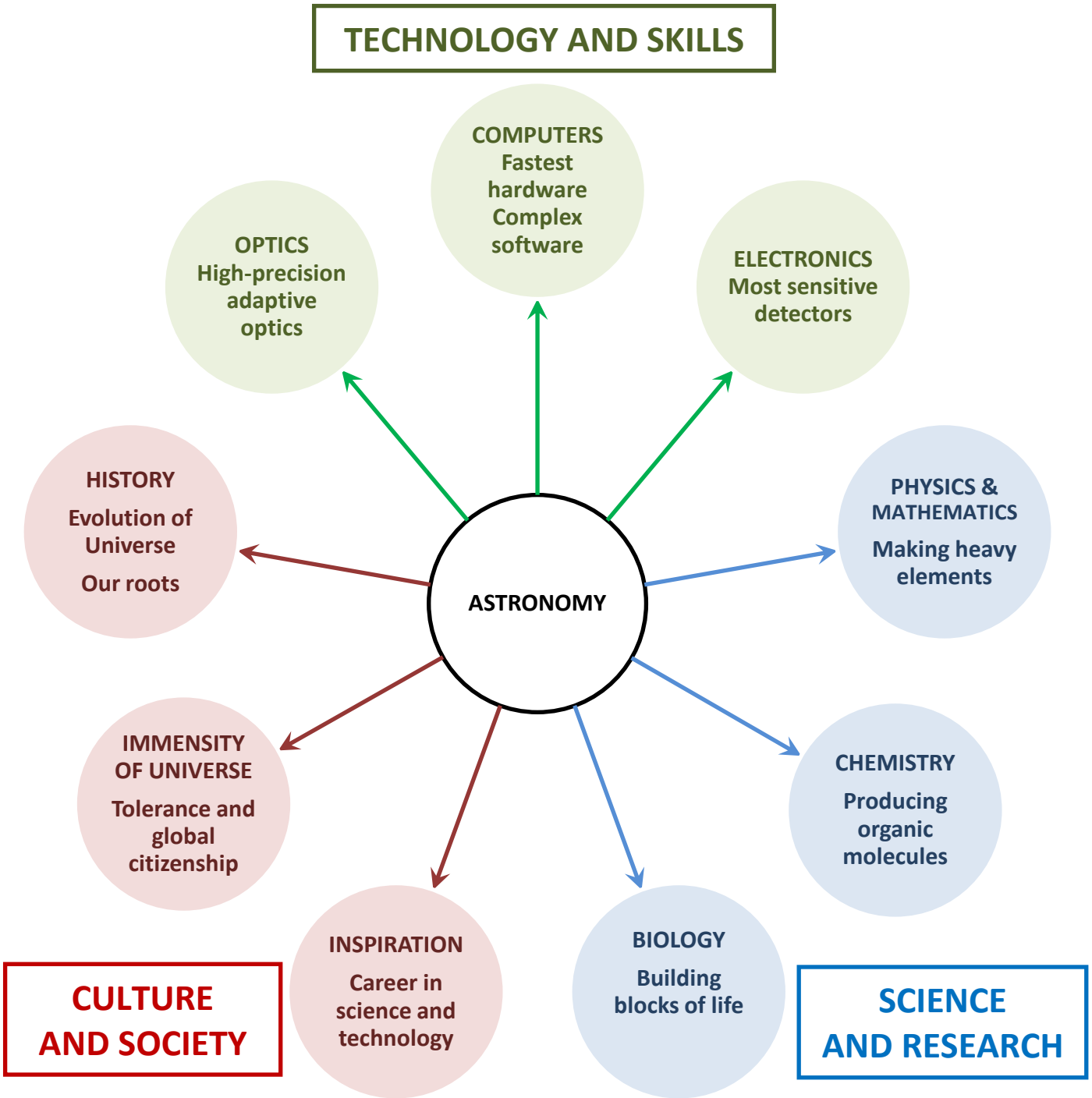
INTERNATIONAL ASTRONOMICAL UNION

ASTRONOMY FOR THE DEVELOPING WORLD

STRATEGIC PLAN 2010 - 2020



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TELESCOPES, SATELLITES, ELECTRONICS, OPTICS
PRETTY IMAGES, INSPIRED CHILDREN

FOREWORD

This is a third draft of an IAU decadal strategic plan for the advancement of astronomy in developing countries.

The IAU Executive Committee regards stimulating astronomy education and development throughout the world as one of the most important tasks of the Union. Over many years the accomplishments of Commission 46 and its various program groups in this area have been impressive. Much has been achieved with few resources. With the impending International Year of Astronomy, the EC regards this as an opportune time to review the long-term strategy of the IAU in development and education. At its 83rd meeting in 2007, the Executive Committee asked me to take on the EC portfolio related to Commission 46 activities and to produce a strategic plan for IAU involvement in development and education during the next decade.

There are several reasons why such a decadal plan is needed. First, technology is changing. The widespread access to the internet and the future availability of remotely operated telescopes for education are important opportunities that should be exploited. Secondly, several new programs outside the IAU are contributing substantially to astronomy education, particularly at the secondary and primary levels. Given the limited available resources, coordination and focusing of the various IAU and non-IAU programs can produce a program that as a whole is greater than the sum of its parts. Thirdly, to augment efforts in this area additional funding is needed. An ambitious and well-founded strategic plan is a prerequisite for any attempt to solicit additional external funding.

We therefore embarked on an exercise designed to produce a plan for ratification at the IAU General Assembly at Rio de Janeiro in August 2009. This plan addresses the rationale for astronomy development, education at the primary, secondary and tertiary levels, public outreach and the development of an infrastructure for research.

An informal "brainstorming" meeting was held at the Institut d'Astrophysique, Paris from 28 – 30 January 2008, on the initiative of the IAU Executive Committee. Present were the President and Vice President of Commission 46, Magda Stavinschi and Rosa Ros, the chairs of some relevant program groups, John Hearnshaw (WWDA), Ed Guinan and Larry Marschall (TAD), Jean-Pierre De Greve and Michele Gerbaldi (ISYA), the IAU Officers (Catherine Cesarsky, Bob Williams, Karel van der Hucht and Ian Corbett) and the responsible IAU Vice President (George Miley). In addition there were representatives from the following related programs: The Japanese Tripod, ODA program (Kaz Sekiguchi), IYA Cornerstone 11/ Africa Plan (Kevin Govender), Las Cumbres Observatory/ Faulkes Telescopes (Paul Roche), Hands on Universe (Roger Ferlet), and Universe Awareness (Carolina Ödman).

The meeting was lively and resulted in several interesting ideas, most of which are included in the draft plan presented here. Thanks to all who contributed. Specifically, John Hearnshaw provided the data on which Figure 2 is based and proof-read various versions of this document. Kevin Govender provided me with Appendix C.

Funding the plan will be a huge challenge. However, without a well-developed plan that can appeal to potential fund-givers, there is little chance of increasing funds for astronomy development. I believe that the astronomy development activities are sufficiently important

to be attractive to potential fund givers and that the plan is modest in scope compared to the annual global cost of ground-based and space research in astronomy.

The first draft of this plan was discussed by the Executive Committee of the IAU at their 84th meeting on 28 - 30 May 2008. There was general agreement that the vision and goals of the plan are laudable, that the introduction of the suggested new programs should be supported. Ways for funding the plan should be investigated.

After consultation with the various stakeholders and outside bodies such as UNOOSA, COSPAR and URSI, a revised version of this plan will be submitted for approval of the Executive Committee during the latter part of 2008 and a final document will be distributed widely and posted on the web early in 2009. Our aim is to have a discussion of the plan at the General Assembly at Rio de Janeiro in August 2009 and to produce a final version shortly thereafter.

Please send comments and/ or suggestions on the plan to me.

Many thanks.

George Miley (miley@strw.leidenuniv.nl)
IAU Vice President

CONTENTS

EXECUTIVE SUMMARY

Astronomy embodies a combination of science, technology and culture, all important elements of international development.

- A challenging science in itself, astronomy is also an exciting gateway to physics, chemistry, biology and mathematics.
- The need to study the faintest celestial object has driven advanced developments in electronics, optics and information technology
- The quest to explore the Universe satisfies the deepest cultural and philosophical yearnings of our species and can stimulate a sense of global citizenship

Astronomy inspires teenagers to choose a career in science and technology and is a staple of adult education. Many large international telescope facilities are accessible to all astronomers throughout the world, providing an inexpensive entry to cutting-edge international research for developing countries.

The International Astronomical Union regards access to knowledge about the Universe as a birth right of all people and furthering the exploitation of astronomy for sustainable global development as an important part of its mission (Section 1.1). We here present an ambitious decadal strategic plan for stimulating astronomy in the developing world. The plan shows that astronomy can make an important contribution to global development and outlines a strategy for furthering this process.

The Union presently conducts a range of activities directed towards education and development, with emphasis on universities and research (Section 1.2; Appendix A). Several complementary programs have recently been initiated by IAU members for exploiting astronomy in primary and secondary education (Appendix B). During the next decade the IAU intends to expand its role in furthering the use of astronomy at all levels in developing countries, working closely with relevant external organizations and using the International Year of Astronomy in 2009 as a springboard. The vast reservoir of talent presently active in astronomy throughout the world will be exploited and mobilized to further sustainable global development.

The long-term vision of the IAU (Section 3.1) is that:

- All countries will participate at some level in international astronomical research,
- All children throughout the world will be exposed to knowledge about astronomy and the Universe.

Goals for the next decade are:

- Raising the level of astronomy development in as many countries as possible, so as to maximize the size of population reached.
- Working to include aspects of astronomy as aids to the primary and secondary education of as many children as possible.

To achieve these goals existing efforts will be intensified, new programs will be initiated and the IAU development activities will be incorporated into a more professional organizational structure (Section 3.2).

Ingredients of the strategy include the following:

- **An integrated strategic approach** involving primary, secondary, tertiary and research education and public outreach. The strategy will be based on the future potential for astronomy research and education in each country, using objective data (Section 2.3), augmented by advice from experts in the region (Section 3.3.3). Because of its relative underdevelopment, Sub-Saharan Africa is a region that will receive special attention.

- **Enlarging the number of active volunteers.** Present activities depend entirely on volunteers, both for their coordination and implementation. The IAU aims to enlarge the number of volunteer-experts by recruiting more members and augmenting the pool of volunteers by doctoral and postdoctoral trainees and talented non-member experts on pre-tertiary education and outreach (Section 4.3).

- **Initiation of new programs.** The IAU will begin several new programs to stimulate astronomy development (Section 3.3; Fig. 5).
    - An endowed lectureship program will provide semi-popular lectures on inspirational topics in modern astrophysics for high-school students and the general public in developing countries.
    - An institute twinning scheme will encourage developed astronomy institutes to provide long-term guidance and advice to university departments in developing countries interested in building up an astronomy research capability.

- **Creation of a Global Development Office.** Mobilizing a larger number of volunteers and implementing new programs cannot be achieved, without some professional coordination. A crucial step is the creation of a small IAU Global Development Office, led by an IAU Director of Development and Education. (Section 4.1)

- **Increasing regional involvement.** An important component of the plan is the adoption of a "bottom-up" approach for astronomy development, with a substantial degree of decentralization. This will involve the appointment of regional development coordinators and the designation of regional "institute nodes". The regional coordinators will coordinate development efforts throughout their geographical region (Section 4.2).

- **Global task forces.** After the pool of volunteers has been increased, the global activities will be consolidated into three task forces to cover the various sectors of astronomy development. (Section 3.4).

Evaluation and assessment will be an essential part of every component of the plan. The strategy will be implemented flexibly, taking account of available funding (Section 5.3). The total annual cost of the plan is about € 1 million (Table 2), an order of magnitude larger than the present cost of the IAU astronomical development program, but very small compared with the annual global expenditure on astronomical research.

Funding the plan will need an innovative approach and action on several fronts. First, an "astronomy development levy" on the IAU dues of wealthy countries will be considered as a way of funding the IAU Global Development Office, an essential component of the plan. Secondly, vigorous attempts at external fund raising will be made, with approaches to international and regional aid agencies, national governments, industry and private

foundations for support of various aspects of the plan. Thirdly, in-kind contributions from developed astronomical institutes and national astronomical societies will be sought. Fourthly, consideration will be given to adopting a target of at least 0.7% of the budgets of astronomical institutes and astronomical projects in rich countries for furthering astronomy education and research in developing countries. This would be in line with the well-established United Nations target for development aid.

1. INTRODUCTION

1.1 Relevance of Astronomy for development and capacity building

From the dawn of history, astronomy has been an important factor in human development. The beauty and regularity of the sky has been a source of wonderment and the ability to predict the motions of the Sun and stars were decisive factors in the emergence of agriculture and navigation in early civilizations. A yearning for knowledge about our roots has resulted in a deep curiosity about the origin and history of the Sun and Moon, the stars and galaxies and the Universe itself.

Because it embodies a unique combination of science, technology and culture, astronomy continues to play an important role in modern society. On the one hand astronomy has driven developments in several areas of advanced technology and on the other hand, the astronomer is the ultimate historian who delves much deeper into the past than conventional historians.

There are several reasons why astronomy plays a special role in furthering the advancement of science and technology and imbuing students with useful skills.

- The Universe provides a laboratory for studying extreme conditions that are inaccessible on Earth. Stars and galaxies are environments that have produced the chemical elements around us and formed organic molecules, the building blocks of life. During the last century astronomical studies have led to new discoveries in physics, chemistry and biology and to the creation of the new sciences of astrophysics, astrochemistry and astrobiology. Because of its mathematical basis, astronomy is also an excellent tool for teaching mathematics.

- Astronomy has been an important driver for the development of advanced technology, such as the most sensitive detectors of light and radio waves and the fastest computers. The need to study the faintest objects possible requires sophisticated electronics and extreme-precision adaptive optics as well as state of the art engineering. Modern optical and radio telescopes are among the most advanced machines ever built and are outstanding educational vehicles for becoming familiar with the latest complex technology.

Astronomy also contributes substantially to modern culture and is relevant to several topical issues of present-day society.

- Because radiation from the distant Universe takes so long to reach the Earth, the astronomer can probe deeply into our past. Large telescopes operating throughout the electromagnetic spectrum are “time machines” that routinely provide pictures and other information about of the observable Universe close to its birth, 13.7 billion years ago. Unravelling the history of the Universe has been a crowning achievement of humankind during the last half century.

- One of the most important societal functions of modern astronomy is as a tool for education in the broadest sense. Because it is one of the most approachable of sciences that consistently fascinates young people, astronomy is an excellent vehicle for introducing science and technology to children. The accessibility of the sky, the beauty of cosmic objects and the immensity of the Universe are inspirational and

provide a perspective that encourages internationalism and tolerance. The excitement of astronomy has stimulated large numbers of young people to choose a career in science and technology, thereby contributing to the "knowledge economy" of many countries.

In summary, because astronomy combines science and technology with inspiration and excitement, it can play a unique role in facilitating education and capacity building and in furthering sustainable development throughout the world.

1.2 The IAU and world astronomy development

The International Astronomical Union (IAU) is an organization of professional astronomers founded in 1919 whose mission is to promote and safeguard the science of astronomy in all its aspects through international cooperation. Now, at the onset of the twenty first century, the Union regards access to knowledge about the Universe as a birth right of people in all countries and considers the dissemination of astronomical knowledge throughout the world as one of its most important tasks.

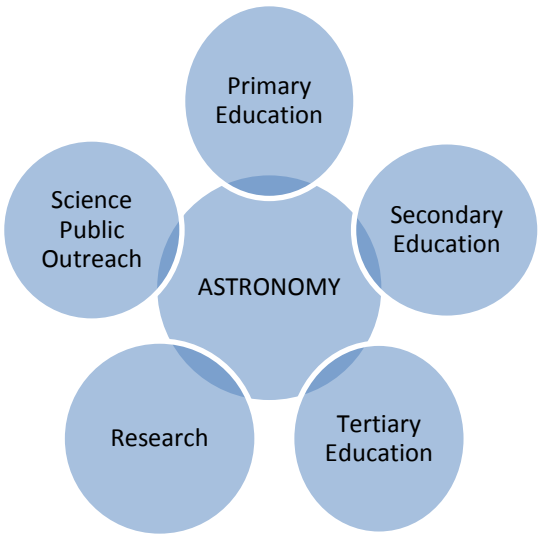
This document is a decadal strategic plan for stimulating astronomy in developing countries during the period 2010 – 2020. The plan shows that astronomy can make an important contribution to sustainable global development and outlines a strategy for furthering this process.

2. ASTRONOMY DEVELOPMENT

2.1. Elements of astronomy development

As outlined in Section 1.1, because of its combined inspirational, scientific and technological aspects, astronomy can play a unique role in education at all levels and raising public awareness about science. Furthermore, unlike most sciences, astronomers can participate in frontier astronomical research, no matter where they are based. Many of the cutting-edge ground-based and space facilities developed for astronomy are available for use at no cost by scientists throughout the world.

Figure 1. Elements of astronomy development. Fundamental ingredients for national development to which astronomy can make a unique contribution.



2.1.1. Primary education (ages 4 – 10). The early formative years are crucial in the development of the human value system. At these ages children can readily appreciate and enjoy the beauty of astronomical objects and can learn to develop a 'feeling' for the vastness of the Universe. The sky and the Universe can excite young children and stimulate their imaginations. Exposure to inspirational astronomical themes can help broaden the minds and stimulate a world-view. Furthermore, astronomy is an excellent and exciting introduction to the scientific method and the concept that nature can be interrogated by rational means.

2.1.2 Secondary education (ages 11 – 18). Astronomy is an outstanding medium for stimulating the interest of secondary school students in science and technology. The Universe and space travel are fascinating subjects in their own right. These topics can be integrated into physics, chemistry, biology and mathematics teaching and provide a link with technology and engineering studies. Recently, educational networks of telescopes have been developed that enable school children throughout the world to do astronomical observations by means of the Internet and introduce children to exciting scientific research.

2.1.3 Tertiary education and research training. The link with astronomy is a frequent reason for young people to choose to study the physical sciences at University and the study of astronomy provides an excellent preparation for many careers in technology and management. Astronomy deals with material, which is much denser and much sparser than anything that can be produced on Earth. Analysing phenomena under the extreme conditions that are present in astrophysical objects develops problem solving abilities. Furthermore, modern astronomical research is often carried out in international collaborative teams, which by necessity develops managerial and people skills.

2.1.4. Research capabilities and infrastructures. Much modern astronomical research requires facilities that are too expensive even for individual developed countries to build and operate. The realization of such facilities has frequently necessitated large international collaborations. Nevertheless, many of the largest astronomical telescopes and satellites and their archival treasures can be used by astronomers throughout the world, no matter where they are based, providing an easy and relatively inexpensive entry for developing countries into inspirational and visible world-class international research.

2.1.5. Public outreach. Astronomy is the most approachable of all sciences for the general public. Compare the relative attention that astronomy receives in the newspapers and other media of most countries with that devoted to most other sciences. Everybody can gaze at the sky and appreciate its beauty. The evocative images produced by modern telescopes fascinate, whereas stories about exotic cosmic objects and the evolution and origin of our Universe can inspire, entertain and stretch the imagination. Information about the state of the Universe in the distant past has deep implications about the roots and future of our species. Astronomy provides an ideal introduction for teenagers to the creative excitement of the exact sciences and frequently stimulates students to embark on a scientific career. The adventure of astronomy is a popular ingredient of adult education programs.

2.2 Present programs and activities for furthering astronomy in developing countries

The Union presently works to promote astronomical education, research and public outreach through two commissions of its members. Commission 46 is concerned with “Astronomy Education and Development” and Commission 55 is devoted to “Communicating Astronomy with the Public”. The IAU Executive Committee performs an oversight role of development activities and, with the assignment of the portfolio of Development and Education to a Vice

President, is playing an active role in the development of overall strategy. Until now, the coordination and implementation of all IAU activities pertaining to development and education has been carried out on a purely voluntary basis.

As part of Commission 46, four main "program groups" are involved with furthering astronomy in the developing countries. These program groups are the "World Wide Development of Astronomy (WWDA)", "Teaching for Astronomy Development (TAD)", the "International Schools for Young Astronomers (ISYA) and "Exchange of Astronomers". A brief description of the goals and activities of each of these groups is given in Appendix A. The present annual budget for all these activities is ~ CHF 120,000, about 10% of the total annual expenditure of the IAU.

As an additional stimulus of astronomy development, the IAU provides funding for symposia on astronomical research topics, a triennial General Assembly and regional meetings. A significant fraction of this funding is devoted to travel grants to enable scientists in developing countries to attend the conferences.

The IAU also carries out some educational activities jointly with the Committee on Space Research (COSPAR) and the UN Office for Outer Space Affairs (UNOOSA). For example, the IAU and COSPAR co-sponsor one capacity building workshop annually.

Specific IAU activities have until now been understandably biased towards developing tertiary education and building up research capabilities in astronomy. However, recently some programs have been initiated, outside the direct auspices of the IAU for stimulating astronomical education at the primary and secondary levels (See Appendix B). These programs complement present IAU activities. Members of the Union have been involved in their initiation, organization and execution. A list of relevant IAU and complementary activities is given in Table 1. Taken together, they comprise a suite of activities that actively stimulate all elements of global astronomy, from the education of very young children to building up research and public understanding through the donation of small telescopes and planetaria. Global development at all levels is being emphasized in the activities planned for the UN-ratified International Year of Astronomy in 2009 (Section 3.2.7), an initiative of the IAU.

TABLE 1
PRESENT GLOBAL ACTIVITIES FOR ASTRONOMY DEVELOPMENT
Shown here are programs conducted by the IAU (Appendix A) and programs that are complementary to IAU activities (Appendix B) *in italics.*

Public outreach	**Primary education**	**Secondary education**	**Tertiary education**	**Research capability**
Japan:Tripod/ODA	*Universe Awareness (UNAWE)*	*Hands-on Universe (HOU)* *Las Cumbres/ Faulkes Telescopes* *Japan: Tripod/ODA*	Comm. 46 TAD Comm. 46 ISYA	Comm. 46 WWDA Comm. 46 TAD Comm. 46 ISYA Comm. 46 EA

In addition to supporting these activities there is another way in which the IAU encourages the progress of world astronomy. As a prestigious international scientific union, the IAU plays a special role in the discussion of astronomy development with governments and

scientific academies and in interceding about such matters at the highest levels. The IAU is affiliated to the International Council of Scientific Unions (ICSU), a non-governmental organization representing a global membership that includes both national scientific bodies and international scientific unions. When appropriate, the President and officers of the IAU are proactive in persuading the authorities of the importance of astronomy for development and education and in encouraging countries to become members of the IAU.

2.3 State of world astronomy development

The present state of astronomical development, the degree of primary and secondary and tertiary education and the GDP of each country are all factors that need to be taken account in planning and optimising future strategy.

2.3.1 Research: An overview of world development topics in astronomy was given in a special session devoted to this topic at 26th IAU General Assembly[1].

For the purposes of discussing world astronomical development, it is convenient[2] to divide countries into five groups as follows:

- Group 1A: "Developed astronomy research countries A". These are IAU member states with > 4 IAU members per million population, indicative of a thriving astronomy research community.

- Group 1B. "Developed astronomy research countries B". These are IAU member states with between 0.5 and 4 members per million population that participate in or host front-line astronomy research facilities.

- Group 2: "Emerging astronomy research countries". These are IAU member states with between 0.5 and 4 IAU members per million population, that do not participate in front-line astronomy research facilities. They are targets for stimulating growth of their astronomical research.

- Group 3. "Developing astronomy research countries". These are countries that do not adhere to the IAU, but have at least one individual IAU member, indicative of limited involvement in astronomical research. They are targets for stimulating growth of their astronomical research.

- Group 4. "Potential developing astronomy research countries". These are countries with well developed tertiary education that neither adhere to the IAU nor contain individual IAU members. They are targets for stimulating the establishment of astronomy-oriented research groups.

- Group 5. Underdeveloped astronomy countries. These are countries that do not adhere to the IAU or contain individual IAU members whose tertiary education is only weakly developed. They are targets for stimulating the dissemination of astronomy education within their schools.

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1 [1]Proc. Special Session 5, 26th IAU Gen. Assembly, eds. Hearnshaw and Martinez, (2007)

[2] Hearnshaw, Private communication (2008)

Although the above classification method is inevitably arbitrary to some extent, it provides a useful basis for an overall view of the degree of professional astronomy development (tertiary education and research) throughout the world.

It is also convenient to place countries into eight geographical regions as follows:

- Region 1: North America
- Region 2: Latin America (including Central America and the Caribbean)
- Region 3: Europe
- Region 4: Middle East and North Africa
- Region 5: Sub-Saharan Africa
- Region 6: Central Asia
- Region 7: Far East and South-East Asia
- Region 8: Oceania (including Australia and New Zealand)

A summary of the present state of astronomical development in 152 countries as a function of region is given in Figures 2 and 3, which for each region shows the number of countries and the number of inhabitants that fall into each of the above classifications.

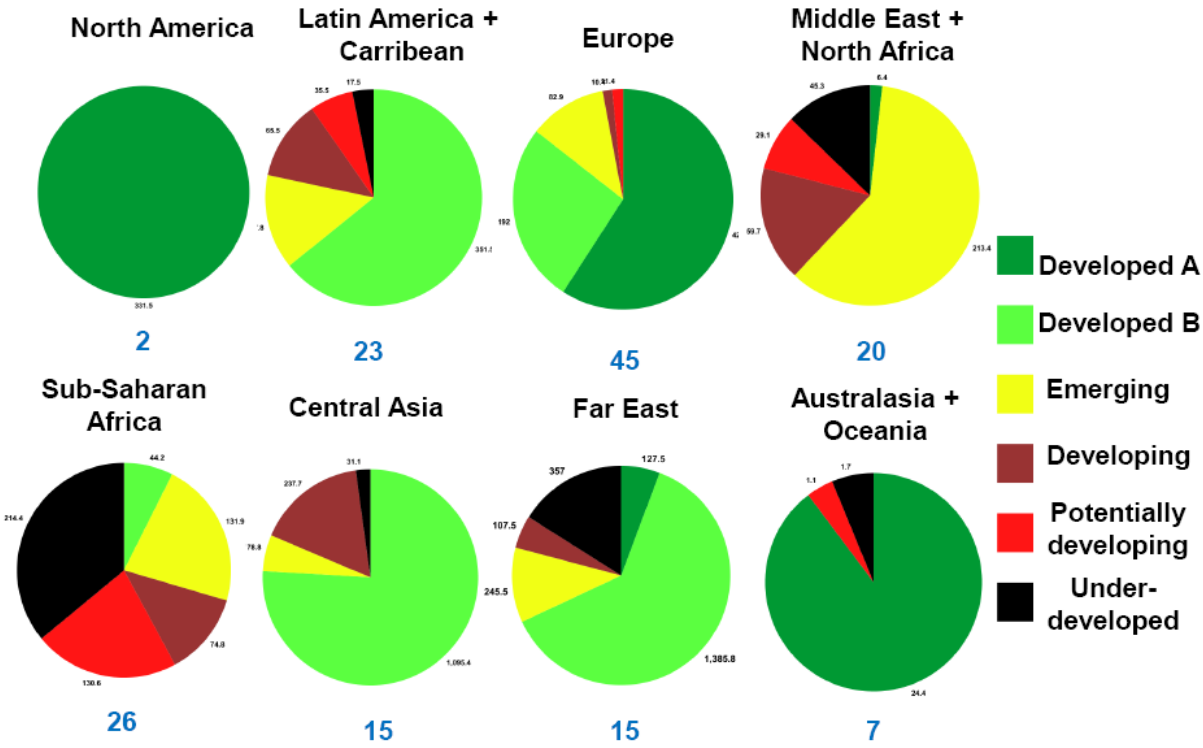

Figure 2. Astronomy research development by region. Population in millions that inhabit countries at various stages of development in different regions of the world. The plots were compiled on the basis of data from Hearnshaw (2008, private communication). The numbers of countries included in each region are indicated in blue.

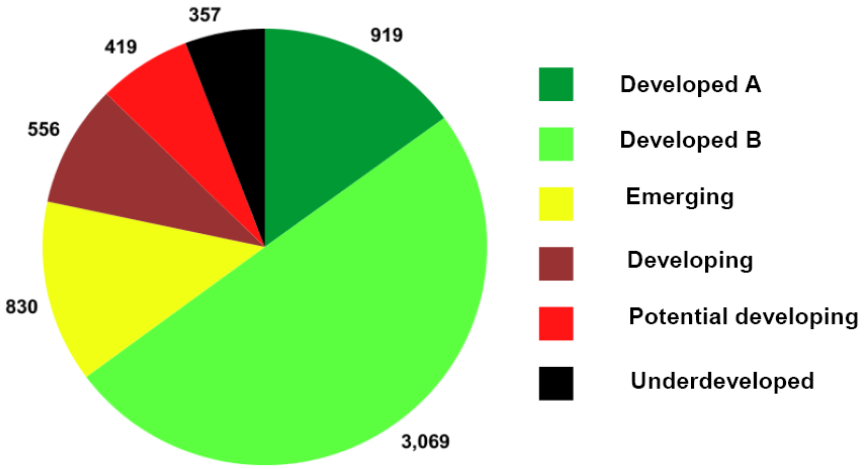

Figure 3. Population in countries in various stages of astronomy development. Number of inhabitants (million) in countries at various stages of astronomy development compiled on the basis of data from Hearnshaw (2008, private communication).

A number of conclusions follow from these statistics.

1. About two thirds of the world's population inhabits Group 1 countries that are developed in astronomical research. However, many of the "developed" astronomy countries in Group 1B have large populations and within these countries there are often substantial regional variations in the degree of astronomy development.

2. There is considerable disparity from region to region. The region that has the largest populations in the least developed astronomical groups is Sub-Saharan Africa

3. As to be expected, there is a strong correlation between astronomical development and gross domestic product (GDP), with poorer countries generally being less developed in astronomy.

2.3.2. Education The state of the educational infrastructure must be an important factor in determining the detailed strategy for astronomy development, particularly in the areas of school education and public outreach. The global distribution of educational index is illustrated in Figure 4. Since not all UN member states choose to or are able to provide the necessary statistics, the data is not complete. Nevertheless, they provide a useful basis for planning future initiatives for programs directed at stimulating astronomy in primary and secondary and tertiary education.

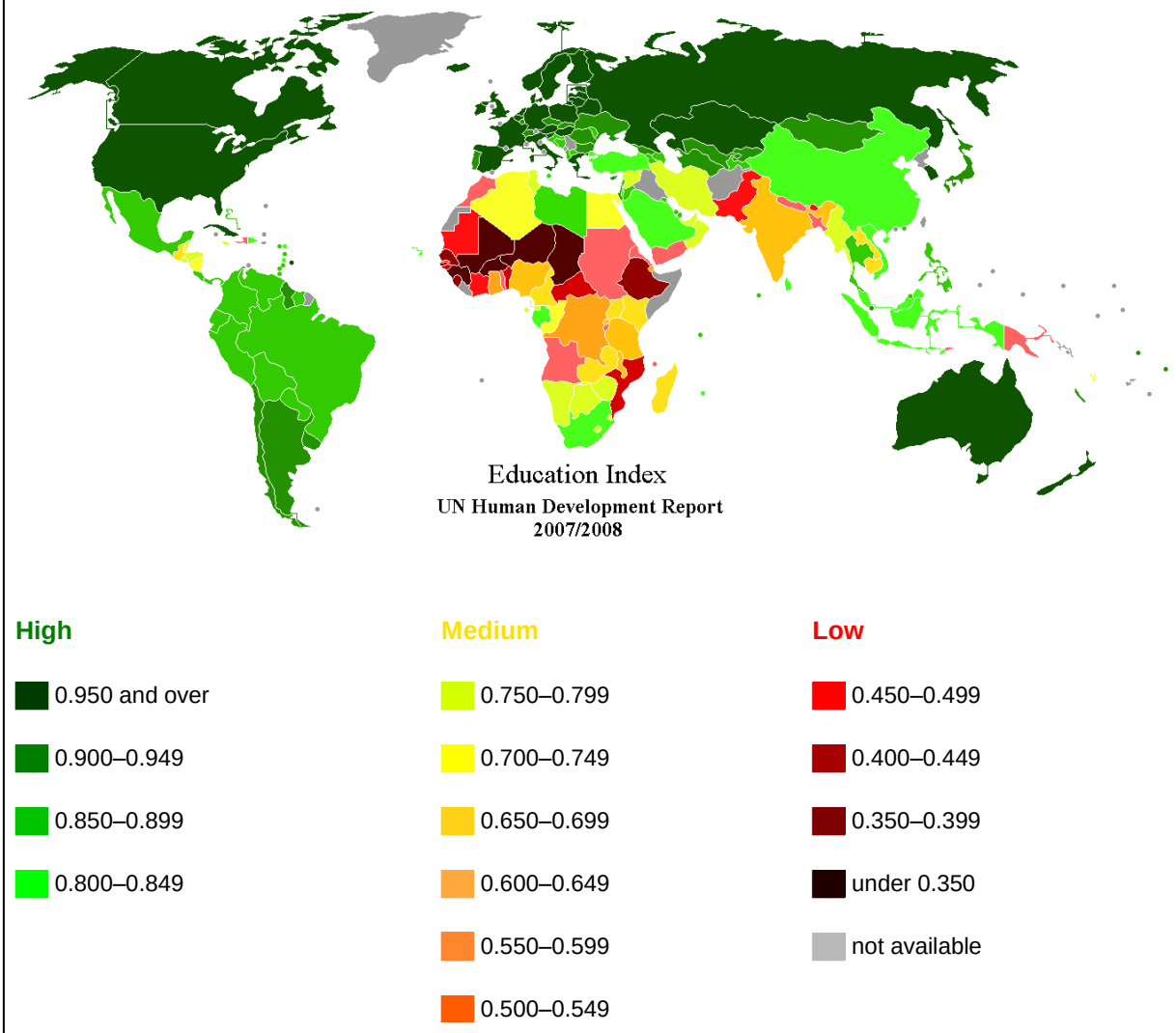

Figure 4. Global distribution of educational index The educational index is defined by E = 2/3 (L) + 1/3 (C), where L is the literacy rate and C is the combined gross school enrolment ratio. This is taken from the 2007/2008 edition of the UN Human Development Report (2007, ISBN978-0-230-54704-9).

Countries can be divided into three broad categories based on their Education Index: high, medium, and low. As is the case with astronomy research development, Sub-Saharan Africa has the largest number of least developed countries as measured by their educational index.

3. STRATEGY FOR THE NEXT DECADE

3.1 Vision and goals

As we discussed in Section 1.1, astronomy can play an important role in stimulating technological development and capacity building. The IAU intends to stimulate this process and encourage the use of astronomy as a tool for capacity building in less developed countries.

The long-term vision of the IAU is that:

(i) All countries will participate at some level in international astronomical research, i.e. satisfy the criteria of Groups 1 and 2 defined in Section 2.3.1 **.**

(ii) All children throughout the world will be exposed to some knowledge about astronomy and the Universe at school in support of their education.

Although this is the ultimate objective of the IAU, achieving such a situation will take several generations to achieve.

For the next decade the IAU has set itself the goals of:

(i) Raising the level of astronomy development of as many countries as possible by one or more categories (Section 2.3.1)***, so as to maximize the size of population reached.***

(ii) Working to include aspects of astronomy in the primary and secondary education of as many children as possible.

To achieve these goals a phased approach will be adopted, in which astronomy development in all its aspects will be addressed - primary, secondary, tertiary education, research and public outreach. The plan focuses a range of resources at international, national and local levels and harness global and regional expertise to achieve the goals. The optimum strategy and mix of programs will differ from country to country, depending on the conditions. Such a strategy can make a unique contribution to sustainable global development.

3.2 Elements of the plan

During the next decade, the IAU will initiate several new programs, intensify existing activities and incorporate astronomy development activities into a more professional organizational structure. In this section the most important elements of the new IAU strategy will be summarized. A more detailed description will be given in Section 4.

3.2.1. Integrated strategic approach. A more integrated approach to astronomy development will optimize available resources in achieving the desired goals. The details of the approach will be based on a careful analysis of the present state and the future potential for astronomy education and research in each country, using objective data, augmented by advice from experts in the region (e.g. Section 3.2.5). The integrated approach will involve all elements of astronomy development outlined in Section 2.1, including primary, secondary, tertiary and research education and public outreach. Coordination of IAU activities (Appendix A) and complementary programs (Appendix B) will maximize the available resources to achieve the agreed long-term goals of the plan. An example of such an integrated plan is given in Appendix D, a strategy for Africa that was developed locally, within the region itself. Because of its relative underdevelopment (Section 2.3), Sub-Saharan Africa is a region that will receive special attention in implementing IAU activities for astronomy development during the next decade.

3.2.2. Enlarging the number of active volunteers. The present IAU activities in the area of development and education depend entirely on volunteers, both for their coordination and implementation. Until now only a few tens of IAU members have been involved actively in such activities out of a total membership of ~ 10,000 established professional astronomers worldwide. During the next decade the IAU aims to enlarge the number of volunteer-experts involved in world astronomy development by actively recruiting more members for such activities. In addition, the pool of volunteers will be augmented by the following categories of non-members (ii) young apprentice astronomers associated with IAU members (doctoral and

postdoctoral trainees) and (ii) non-members that are experts on pre-tertiary education and outreach, such as talented teachers (Section 4.3). This expansion in active volunteers can only be achieved provided the coordination and management of the programs are professionalized (see Sections 3.2.4 and 4.1).

3.2.3 Initiation of new astronomy development programs. New programs will be initiated to enhance IAU development activities.

- An endowed lectureship program will provide semi-popular lectures on inspirational topics in modern astrophysics for high-school students and the general public in developing countries.
- An institute twinning scheme will encourage developed astronomy institutes to provide long-term guidance and advice to university departments in developing countries interested in building up an astronomy research capability.

3.2.4 Creation of an IAU Global Development Office. Mobilizing a larger number of volunteers and implementing new programs cannot be achieved, without some professional management and coordination. For this reason a crucial element of the strategic plan is the creation of a small IAU Global Development Office, led by an IAU Director of Development and Education. We shall elaborate on this in Section 4.1. In setting up the office, care will be taken to ensure that bureaucracy is minimized and that the volunteers involved in carrying out the activities remain motivated and share in the decision making processes.

3.2.5 Increasing regional involvement. There are several reasons for stimulating more regional involvement in IAU astronomy development activities. First, special conditions, opportunities and problems in specific countries are better understood at a regional level and there is a more considered knowledge of the most appropriate people to involve. A realistic assessment of people and local conditions are generally more important than objective criteria in determining whether a country is ripe for sustainable astronomy development. Secondly, contacts are more readily made and travel is less expensive between neighbouring countries. Thirdly, there is usually more affinity in language and background within a region. For these reasons, the decadal plan envisages a more "bottom-up" approach to astronomy development, with a considerable degree of decentralization. Regional coordinators and regional institute nodes will be designated in each of the eight geographical regions. It is expected that the regional coordinators will be familiar with all aspects of astronomy development in the regions and will be best able to mobilize the available local talent. In some countries (e.g. those with little or no astronomy at tertiary level), enthusiastic talented amateur astronomers can be important ambassadors for astronomy development. Although expertise for the various programs will be provided at a global level, advice and input from the regional coordinators will be the determining factors in implementing the various development programs. An example of the regional approach is the draft plan for astronomy development in Africa, included in Appendix C.

3.2.6 Sector-related task forces. After the global development office has been set up, the regional coordinators designated and the pool of volunteers has been substantially increased, the various programs will be reorganized and streamlined to take account of the new situation. The activities will be consolidated by the Global Development Office into three task forces that will cover the various sectors of astronomy development, (i) primary and secondary education, (ii) tertiary and research education and (iii) public outreach. Each sector task force will comprise representatives of relevant programs in the sector, both IAU activities and complementary programs. The task forces will be the descendants of the present program

groups (see Appendix A). It should be noted that several members of Commission 46 are already working towards setting up a global pre-tertiary education network to coordinate astronomy development activities for teachers and schools.

3.2.7. Using the IYA as a springboard. The International Year of Astronomy in 2009 is an initiative by the IAU and UNESCO that has been ratified by the United Nations. The vision of the IYA is to help the citizens of the world rediscover their place in the Universe through the day- and night time sky, and thereby engage a personal sense of wonder and discovery. All humans should realize the impact of astronomy and basic sciences on our daily lives, and understand better how scientific knowledge can contribute to a more equitable and peaceful society. The IYA will include a wide range of activities that will generate momentum and engender public interest in astronomy throughout the world. The strategic plan will build on the momentum generated by the IYA. Several of the global cornerstones adopted for the IYA are relevant to the long-term vision and goals of the IAU and have been incorporated in this plan. The "Galileo Teachers Training Program", "Developing Astronomy Globally" and "Universe Awareness" are examples.

3.2.8. Exploiting new techniques and tools. The use of the Internet and the availability of robotic telescopes for education will be exploited in a global astronomy development and education strategy. Access to a well-supported international telescope network can be a more efficient educational tool for development than attempting to acquire and operate small in-house telescopes. Also internet telephony will allow regular liaison via teleconferencing and videoconferencing to take place between the Global Development Office, the regional coordinators and the various task forces.

3.3. New IAU initiatives for astronomy development.

The decadal strategy envisages the initiation of several new programs by the IAU.

3.3.1 IAU Endowed Astronomy Lectures (EAL). An endowed lecturer program will be a major new initiative to promote interest in astronomy and science in developing countries. The goal of such a program is to facilitate excellent and inspiring semi-popular lectures, thereby enhancing worldwide public interest and understanding in astronomy and the Universe. The target audience will be secondary school students, university students and members of the public.

The following implementation of the scheme is foreseen:

- About 100 invited lecturers of high calibre will be recruited;
- The lecturers will generally be established senior astronomers, who already have a high reputation for their ability to communicate to audiences at the appropriate level;
- About 40 lecture tours per year to developing countries are envisaged;
- The program will be coordinated through the new Global Development Office and overseen by the IAU Executive Committee. The Director of Development and Education will liaise with the regional coordinators (Section 4), institutions/organizations in developing countries and potential visiting lecturers.
- The language for the lectures will depend on the target countries and the available lecturers. Where appropriate, expatriate astronomers with relevant language skills will be recruited.
- The cost of the new program is estimated at ~ €2500 per lecture tour of duration 1 to 2 weeks in a developing country. The cost of 40 such lecturers per annum would be ~

€100,000. This figure does not include the salary costs of the global coordinator, or any incidental administrative costs. This is a program well suited for external funding via endowments, joint ventures with existing endowed lecture programs and in-kind contributions by institutes in developed countries.

3.3.2 Astronomy Institute Twinning (AIT). Another new element of the IAU strategic plan is a long-term program for "twinning" between developed astronomy institutes and institutes and university departments where astronomy is less developed. The goal is to provide guidance in setting up astronomy courses and building up an astronomy research capability. The rationale for this program is that such an association can provide needed continuity and focus for sustainable astronomy development.

The following implementation of this scheme is foreseen.

- Each medium-sized astronomy department or institute in a developed astronomy country will be encouraged to develop relations with at least one interested university department in a developing country, e.g. a physics department that is interested in developing astronomy.
- The developed institute will provide expertise and advice on astronomy development and fund at least one visit by a staff member to the developing institute every year, possibly augmented by exchange visits.
- A commitment would be expected to continue the relation for a period of at least 5 years.
- The program will be coordinated through the new Global Development Office with input from the regional coordinators. Oversight will be provided by the Executive Committee.
- The IAU Global Development Office will be proactive in stimulating institute twinning, provide an official endorsement for the agreements and integrate institute twinning within the overall development strategy.

3.3.3 IAU regional nodes for astronomy development. A key element in the new strategy will be to inject more regional input into the IAU development activities. To this end, the IAU will work towards establishing regional institute nodes. Initially the goal will be to cover those parts of the world most in need of astronomy development.

A regional node will be an existing astronomical institute engaged in both research and promoting astronomy education at all levels. The latter activity is more likely to be through workshops, conferences, short refresher courses for teachers and schools for students, rather than in formal degree programs.

There is already at least one role model for such a regional node. The South African Astronomical Observatory (SAAO) at Cape Town, South Africa presently acts as an effective node for much of Africa. It provides excellent facilities for computing, library, conferences and access to optical and radio observing facilities and organises numerous outreach programs and courses for teachers. It facilitates visitors from many countries in Africa and provides considerable assistance in building up an educational and research capability in such countries.

The following implementation of the regional node scheme is foreseen:

- Each regional node will be responsible for optimizing astronomy development in the region by helping to frame the IAU regional development strategy and its

implementation, hosting graduate programs for students in the region, providing graduate and undergraduate schools and teacher training courses. They will also provide input for the endowed lecture program, be proactive in ensuring that IAU regional assemblies are held every three years and take the lead in regional fund raising activities in support of local astronomy development.

- Where conditions are appropriate, at the instigation of the regional node, the regions may be divided into smaller sub-regions, each with its own sub-regional hub-institute for astronomy development.
- A goal for the next decade is for each regional node to organize at least one school for graduate students and one teachers training course annually and a regional IAU assembly every 3 years.
- All these tasks will be carried out in close collaboration with the IAU Global Development Office and the global task forces for schools, universities and public outreach.
- The IAU will enter into contractual arrangements with existing institutes, in which those institutes would receive an additional grant to provide regional services as a node for a period of 5 years.
- The IAU will work towards establishing regional development nodes operating in all in five regions (Section 2.3) by the end of the decade, funding permitting. A start will be made by establishing regional nodes in at least two regions most in need of astronomy development.
- The cost of operating a regional astronomy node from an existing institute is estimated to be about €30,000/yr for which half would be spent on tertiary and research education and half for primary, secondary education and public outreach. This budget would fund up to 15 visits from visiting astronomers in the region to take place, at typically €1000 per visit. An additional €15,000/yr would be reserved for outreach to schools and public awareness. With five regional nodes, a total annual budget of €150,000 would be required. Each node will be required to submit an annual proposal and report.
- A task for the new Global Development Office will be to gauge the interest of possible host institutes in the various regions and, if needed, organise an announcement of opportunity and selection procedure for candidate nodes.
- It is envisaged that each node will appoint and fund a regional coordinator (~0.5 FTE, Section 4.2), who will liaise with the global development and education office and astronomers and educators in countries within the region. The regional coordinators will also advise the coordinators of each of the global programs about the optimum strategy and tactics to follow in the region.

3.4 Enhancing existing IAU programs – sector task forces

As mentioned in Section 2.1, IAU Commission 46 has been involved for several years in several successful activities directed towards developing astronomy throughout the world. During the next decade the present activities of Commission 46 and 55 in this area will be intensified. An early task of the new Director of Development and Education in consultation with the regional coordinators will be to recruit additional volunteers and funding for development activities. The organization and oversight of these activities will then be rationalized to take account of the new management structure and the results of fund raising and recruitment.

Three global task forces will be set up to carry out activities in the various areas of astronomy development, (i) primary and secondary education, (ii) tertiary education and research and (iii) public outreach. The strategy for each of these task forces will be determined by agreement between the task force, the global development office and the regional coordinators. Several of the planned activities impinge on more than one task group. For example, visits to developing countries by established astronomers can be relevant for tertiary education, secondary education and public outreach (endowed lectures) and such visits will be coordinated by the regional coordinators to optimize the outcome.

3.4.1 Astronomy for Universities and Research (AUR). Past IAU development activities (Appendix A) have emphasized astronomy in tertiary education and research. Presently, there is some overlap in the tasks of the relevant program groups, World Wide Development of Astronomy (WWDA), Teaching for Astronomy Development (TAD), Exchange of Astronomers (EA) and International Schools for Young Astronomers (ISYA). The new Global Development Office will coordinate activities and consolidate the presently overlapping tasks of the four relevant program groups into a task force for the development of astronomy in tertiary education and research – "Astronomy for Universities and Research". The incorporation of these activities into a sector task force will stimulate more coordination between the programs. Furthermore, the activities of the programs will benefit from regional input, once the regional coordinators are appointed and the regional nodes are in place. A summary of the proposed activities is given in Figure 5.

In stimulating astronomy in tertiary education and research the Astronomy for Universities task force will continue to concentrate on countries in Groups 2, 3, and 4 (Section 2.3) as at present, with special emphasis on Africa (See Section 3.2.1). Specific goals will be:

- To increase the present IAU membership of 65 countries to about 80 during the timescale of this plan. This will be achieved by attempting to double the present number of exploratory visits to such countries from 2 - 3 per year to 5 - 6 per year. There will be close liaison between the taskforce, IAU Global Development Office and the regional coordinators regarding the selection of appropriate target countries, the choice of lecturers and the implementation of the visits to achieve the agreed decadal strategic goals. Where possible, the "research-oriented" lecturers will be urged to give additional semi-popular lectures under the auspices of the new endowed lecture program. Visits of expatriate astronomers to their countries of origin will be particularly encouraged.
- To increase the frequency of the highly successful regional "International Schools for Young Astronomers" (ISYA) from one per year to three per year, with increased involvement of the regional coordinators. They would be organized through the new regional nodes (Section 3.3.3) and coordinated by the appropriate members of the sector task force.
- To establish an ISYA Alumni Community. This will result in a network of researchers who have experienced the regional schools and a vehicle to stimulate future interactions between them. Furthermore, the existence of such a network will allow the impact of the schools to be evaluated, e.g. via follow-up questionnaires over a long timescale.

The current budget of the four program groups together is CHF 120,000 (~ €105,000). To achieve all the goals would require an annual budget of €380,000/yr for the task force, a substantial increase. To achieve such a funding level, a source of external funding will be needed (Section 5).

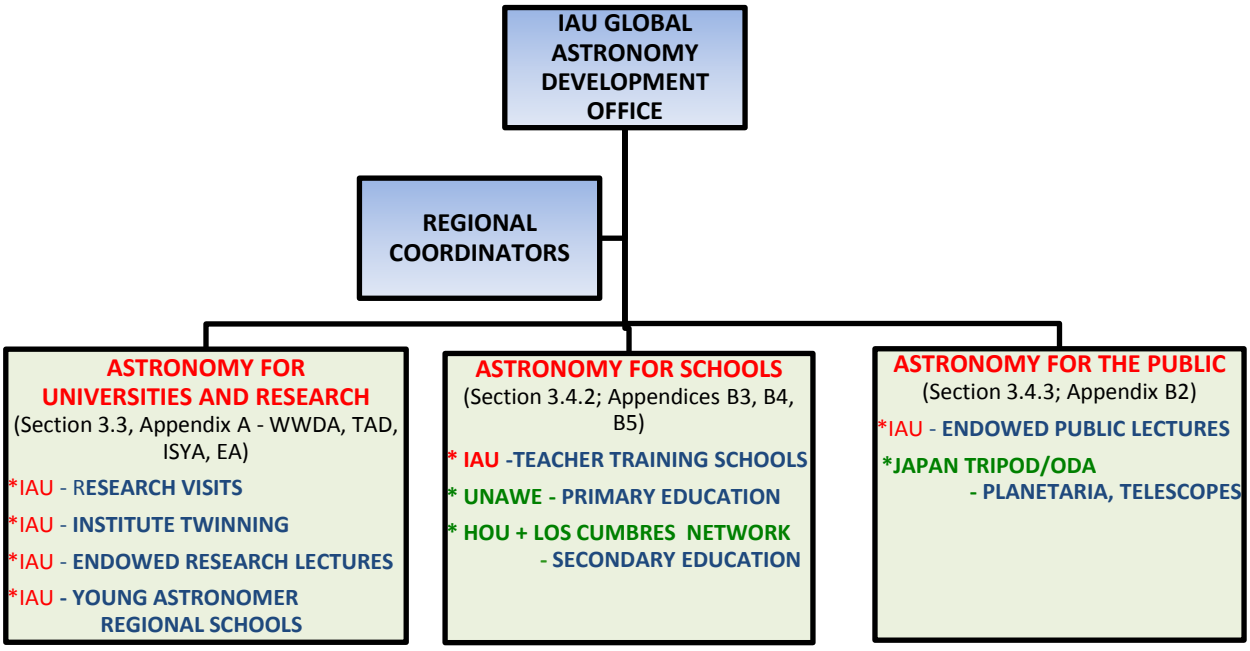

Figure 5 Future astronomy development activities to be coordinated by the three IAU task forces. Activities are shown in **blue**. IAU activities are prefixed by **red** and complementary programs are prefixed by **green**. Representatives of complementary programs will be included in the relevant task forces.

3.4.2. Astronomy for Schools (AS). At the instigation of several members of Commission 46, the IAU is presently considering setting up a new program group consisting of a network dedicated to primary and secondary education in astronomy (Network for Astronomy School Education, NASE). This network will liaise with and support existing programs in the area (Appendix B), in close consultation with the global development office and the regional coordinators. Specifically, NASE will stimulate regional training courses for teachers, make inventories of suitable educational materials and organize the development and translation of materials and curricula.

The new IAU Network for Astronomy School Education will form a nucleus for the task force "Astronomy in Schools". It will build on the IYA "Galileo" global cornerstone program and existing regional activities, such as those of the European Association for Astronomy Education. The task force will be coordinated by a committee that includes representatives of the various programs involved in primary and secondary education (Appendix B). The global strategy of the network will be determined by the task force together with strong involvement by the regional coordinators. Outreach to teachers in the developing world will involve the preparation and translation of materials, the provision of training courses and harnessing global technological resources in the service of primary and secondary education. A specific goal will be to provide expertise for at least one teacher training course in each region every year, to be organized together with the regional coordinators.

3.4.3. Astronomy for the Public (APU). A new task force will be set up to coordinate global public outreach programs in developing countries. The purview of this task force will include the new IAU endowed lecturer program, the use of planetaria and small telescopes in

outreach activities and harnessing the contribution of amateur astronomy groups. As with the other task forces, strategy will be determined in close consultation with the IAU Global Development Office and the regional coordinators.

4. FACILITATING THE PLAN

The decadal plan is a highly ambitious one that will require a new organizational structure and a substantial increase in funding. The two most important prerequisites in adopting the plan are (i) the creation of the IAU Global Astronomy Development Office led by a Director of Development and Education and (ii) a proactive drive to seek additional sources of funding. A summary of the plan and possible future organizational structure is shown in Figure 6. Specific aspects of the proposed new organizational structure will now be discussed in more detail.

4.1 Global Development Office (GDO)

The creation of an IAU global coordinating office for development and education is an essential part of this plan. In the present organizational structure, the IAU development programs are administered and implemented entirely by volunteers. The scope and diversity of present astronomy development programs and the ambitions of the IAU for the future are no longer compatible with a purely volunteer-administered system. The time has come to build on past success by introducing a more professional management structure and the creation of a small Global Development Office (GDO). The GDO will be a catalyst for facilitating a larger number of volunteers to be mobilized for astronomy development activities and provide the coordination needed for an integrated strategic approach.
Among the tasks envisaged for the Global Development Office will be:

- Management, coordination and evaluation of all the IAU programs in the area of development and education
- Organization of oversight of the IAU development programs and the establishment of their annual budgets
- Liaison with the chairs of the various Commission 46 program groups/ sector task forces in planning and implementing the relevant programs
- Liaison with the IAU regional coordinators and IAU regional nodes in planning and implementing the relevant programs
- Provision of administrative support for IAU programs in development and education.
- Coordination of contacts between the IAU and national authorities
- Establishment of the new IAU endowed lectureship program described in this document
- Liaison with other international unions and agencies promoting astronomy in the developing world, such as the UN Office for Outer Space Affairs (UNOOSA), the Committee on Space Research (COSPAR) and the International Union of Radio Science (URSI).
- Stimulation of communication on IAU development matters between members and associated members through the maintenance of an IAU website for development and education and appropriate forums
- Provision of information for astronomers in all developing countries about IAU programs.
- Proactive coordination and initiation of fund raising activities for astronomy development.

The office will consist of:

- A Director of Development and Education (DDE) (1 FTE). It is envisaged that this full-time position would be filled by an astronomer or scientist in an allied field with management experience, good international contacts and affinity both with education at all levels and with international development programs. This is a critical position that will require extreme care in recruiting and appointing a suitable candidate. The DDE will report to the General Secretary of the IAU.
- An Executive Assistant that will support the DDE (1 FTE). The EA should be a university graduate or equivalent who is able to deputize for the DDE, where necessary.
- A Webmaster (WM) (0.3 FTE) who will be in charge of maintaining the web site.

Proposals will be invited from institutes around the world willing to host such an office. Selection will be made by the IAU Executive Committee on the basis of criteria such as the resources infrastructure and support offered by candidate host institutes, the availability of a suitable DDE and the optimum location for the activities to be carried out.

4.2. Regional coordinators

The plan foresees the appointment of regional coordinator in each of the geographical regions of the world at a typical level of ~ 0.5 FTE. In regions for which institute nodes are designated (Section 3.3.3), the regional coordinators will normally be associated with and funded by the relevant institute. The ability to provide such a regional coordinator will be a criterion for selection of an official regional node institute. The IAU may provide funding for travel and other expenses of the regional coordinator. The need for a regional coordinator is more critical in some regions than others, depending on the degree of astronomy development. A stage by stage approach is envisaged, beginning with the designation of regional coordinators in a few regions, building up to six regional coordinators at the end of the decade.

The regional coordinators will typically be scientists with good regional contacts, affinity with education and astronomical outreach at all levels and preferably some experience of international development programs and activities.

The tasks of the regional coordinators will include:

- Fostering the development of astronomy education and research in countries throughout the region.
- Provision of advice to the Global Development Office and the various task forces about opportunities for astronomy development in the region
- Participation in the development and implementation of a strategy for each task force in the region.
- Regular liaison (e.g. by internet telephony) with the Global Development Office about progress in matters pertaining to the development of astronomy.
- Consultation with the relevant task forces and the global development office, in organizing logistics for regional sponsored meetings, summer schools or training courses.

- Take the lead in finding potential regional sources of funding for astronomy development and pursuing these together with the IAU Global Development Office, where relevant.

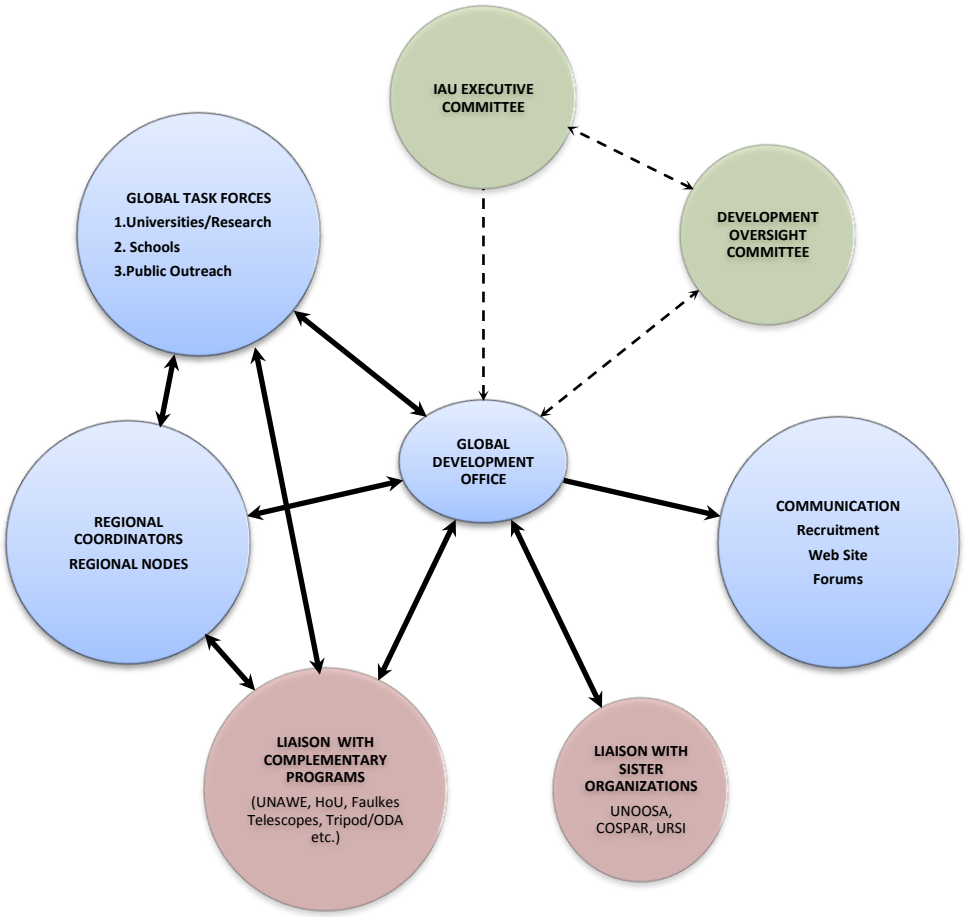

Figure 6. Organizational structure. Schematic diagram of proposed organizational structure and communication lines.

4.3. Enlarging the volunteer base

As mentioned above, there is great potential for mobilizing a much larger number of IAU members and others in development activities than are active at present.

- After a Director of Development and Education is appointed, an active recruiting campaign will be mounted by the new IAU Global Development Office among the 10,000 IAU members. Meanwhile, interest in the topic will be polled in the member registration profile. A pool of members interested in and capable of participating actively in existing or planned development activities (e.g. endowed lectureship program) will be created. This will be exploited for implementing all the various relevant development activities.

- The Global Development Office will mobilize expert non-members to volunteer for the programs. Particularly relevant categories of non-member are:

- *PhD students and postdocs.* Large numbers of IAU members have associated PhD students and or postdoctoral fellows. Many of these are active and enthusiastic young people with considerable expertise. They could contribute a great deal to world astronomy development activities.
- *Teachers and educators*. The involvement of interested school teachers and professional educators in the activities of the new Commission 46 initiative to form a "Network for Astronomy in School Education" and the proposed task force for primary and secondary education is essential.

Depending on how the implementation of the plan develops, it may be desirable at a later date to create special categories of "junior" and "associated" IAU membership for such volunteers. The Global Development Office will have the task of recruiting suitable volunteers and negotiating membership with the relevant task forces.

4.4 Evaluation and oversight

Evaluation and assessment are essential for programs of this type and as far as possible, relevant metrics for measuring effectiveness will be incorporated into all the programs and activities.

The expansion of activities, increased professionalism and creation of the Global Development Office will increase the need for careful oversight of the astronomy development program. This will be provided by the IAU Executive Committee, advised by a special oversight committee set up to review all aspects of the program. This will include members of Commissions 46 and 55 and independent external experts. The Global Development Office will provide the Development Oversight Committee with the material and metrics necessary for their review. The Development Oversight Committee will meet at least once per year, preferably through the use of internet teleconferencing and video conferencing.

5. FUNDING THE PLAN

5.1 Estimated cost

An estimate of the cost of the decadal plan is given in Table 2. The total of ~ €1M per year is an order of magnitude larger than the present cost of the Commission 46 IAU astronomical development program and does not include the cost of the complementary programs described in Appendix B, estimated to be an additional several million Euro per year. Although the plan cannot be funded from the present IAU regular budget, there are external funding possibilities that can be considered.

5.2 Possible funding sources.

Realizing the plan will require an effort to increase the IAU budget, vigorous attempts at external fund raising and a new philosophy for funding existing astronomical programs in the developed world. We shall consider some possibilities that could be pursued by the Global Development Office, possibly with the help of professional fund raisers.

TABLE 2
ANNUAL COST
PROPOSED IAU ASTRONOMY DEVELOPMENT PROGRAM[1]
2010 – 2020

ACTIVITY	SPECIFICATION	ESTIMATED ANNUAL COST (2009 €)	FUNDING OPPORTUNITIES	
			IAU	EXTERNAL
Task force: "Astronomy for Universities" Tertiary education and research	Visits: Research capacity €150,000 Visits: Tertiary education €100,000 Regional training schools (€100,000 Institute twinning	€350,000	Present IAU Com. 46 (CHF 120,000)	"Tax" on institutes and projects in developed astronomical countries Contributions from national governments and development agencies
Task force: "Astronomy for Schools" Primary and Secondary education	Training School	€100,000		
Task force: "Public outreach"	Endowed lecturer program 40 x €2,500	€100,000		External foundations Development tax
First five regional node institutes	5 x €30,000	€150,000		In-kind contributions Development tax
Support for first five regional coordinators	5 x €15,000	€75,000		
IAU Global Development Office	Director 1 FTE Admin. assistant1 FTE Webmaster 0.3 FTE	€250,000	New IAU development levy	In-kind contribution from host institute
TOTAL ANNUAL COST		**€1,025,000[1]**		

[1] *Excluding the complementary and important development activities outlined in Appendix B that are not administered by the IAU, e.g. Tripod/ODA, Universe Awareness, Hands-on Universe, Las Combres Observatories. Additional external funding will be needed for these programs.*

5.2.1. Increasing the IAU Budget. To maintain credibility in external fund-raising efforts, it is desirable that funding for the new Global Development Office be provided by the IAU itself. Given the limited budget of the IAU setting up the GDO without increasing IAU revenue does not seem feasible.

There are several options for increasing IAU revenue for this purpose. These include:

- An astronomy development levy motivated by this decadal plan for member states with GDP per capita larger than €16,000 per year. Initially such a levy might be optional.
- A voluntary contribution from individual members

- Seeking sponsorship

5.2.2. External funding from foundations, industry, national governments and international aid agencies. Specific programs from the strategic plan are well suited for funding by private foundations, industry, national governments or international education aid programs. The combination of scientific technological and cultural aspects makes astronomy an outstanding discipline for profiling the image of a country or an organization that acts as its patron. The involvement of the IAU in such a program adds additional prestige. Fund raising will be a task for the new Global Development Office, working together with the regional coordinators, the Officers and the Executive Committee. Professional fund raisers may be employed in special cases.

- An obvious activity for which external funding should be sought is the new endowed lecturer program.
- Large multinational companies that operate in developing countries will be approached to fund activities in specific countries and regions.

5.2.3. In-kind contributions from developed astronomical institutes and national astronomical societies. Developed astronomical institutes will be approached to make in-kind contributions to world astronomy development. Examples of in-kind contributions could be (i) funding staff lectures as part of the endowed lecture program and (ii) entering into twinning arrangements with institutes or departments in developing countries. Help of well-supported national astronomical societies in developed countries will be sought in pursuing such initiatives.

5.2.4 "Taxing" developed institutes and new projects in astronomy. More than 30 years ago the United Nations urged every developed country to devote at least 0.7% of its GDP to development aid. The 0.7% target was reaffirmed when formulating the Millennium Development Goals and it is still an accepted rule of thumb today. In accordance with the spirit of this resolution of the international community, the IAU should consider recommending that each astronomical institute and new astronomical project will devote at least 0.7% of the cost to an astronomy development. Since more than €1 billion is spent annually on astronomy throughout the developed world, such a levy could produce several million Euros per year for world astronomy development.

5.3 Timeline

This is a decadal plan that necessarily will be implemented in a phased manner and flexibly, taking account of the funding situation. A possible timeline is the following:

2008:	Feedback from stakeholders. Approval by IAU Executive Committee
2009:	Discussion and approval by IAU General Assembly.
2010:	Negotiate IAU development levy with member states Discuss with international development agencies Announcement of opportunity for IAU Global Development Office Announcement of opportunity for IAU Regional Institute Nodes
2011:	Decision about location of IAU Global Development Office

Decision about location of 2 – 4 regional institute nodes
Recruitment and appointment of IAU Director of Development and Education
Recruitment and designation of about 4 IAU Regional Coordinators

2011 – 2013: Start of Global Development Office
Fund raising for development activities
Enlarging pool of volunteers for the development activities
Start of 2 – 4 regional institute nodes
Start pilot program of endowed lectures
Start institute twinning program

2013 – 2018: Build up to 5 regional institute nodes and appoint up to 8 regional coordinators
Build up to a full endowed lecturer program
Build up to a Global Development Office Global Development Office full twinning program

2018 – 2020: Complete implementation of decadal plan

5.4 Conclusion

Modern astronomy is a crowning achievement of human civilization. In this plan we have shown how astronomy can contribute to international development and presented a strategic vision for the furtherance of astronomy in developing countries during the decade 2010 – 2020. The plan is an ambitious one that will exploit many new opportunities for using astronomy in the service of world development provided funding is available.

APPENDIX A
PRESENT IAU ASTRONOMY DEVELOPMENT ACTIVITIES

Presently the IAU spends CHF 120,000 (~ € 105,000) per year, or about 10% of its annual budget on programs designed to support the stimulation of astronomy in developing countries. As part of Commission 46, four main "program groups" are presently engaged in astronomy development. These program groups are the "World Wide Development of Astronomy (WWDA)", "Teaching for Astronomy Development (TAD)", "International Schools for Young Astronomers" (ISYA) and "Exchange of Astronomers". Despite the modest scope of these programs, they have been very successful. A short description of each of these activities follows.

A.1. Worldwide Development of Astronomy (WWDA). The role of the program group for the World-Wide Development of Astronomy (WWDA) is to develop capabilities in astronomy teaching and/or research in countries that have little experience in astronomy. WWDA is often the first point of contact between a developing country and the IAU.

WWDA identifies countries with a potential for astronomy development. The tasks of the program group are carried out through visits to candidate countries and resultant reports and proposals to the President of Commission 46 and the IAU Executive Committee. An essential aspect of the program group's work is to encourage follow up with the higher level program groups of Commission 46 (TAD and ISYA), which deal with developing countries whose astronomy programs are reasonably well established and well known to the IAU.

Between 2003 and the end of 2008 WWDA members will have mounted exploratory visits to the following countries: Bangladesh, Cuba, Ecuador, Ghana, Laos, Mongolia, Mozambique, Iraq, Kenya, Peru, Sri Lanka, Tanzania, Thailand, Trinidad and Tobago, Uruguay, Uzbekistan and Zambia. Typically a visit lasts about a week and involves lectures at a variety of levels (ranging from popular public talks, to university seminars). Contacts with senior university academics, government departments and presidents of academies of sciences are also pursued. The aim is to enthuse students at all levels in astronomy, to encourage university programs in astronomy, to promote follow up contacts with the IAU by astronomers in developing countries, and to assist countries interested in becoming IAU members. Success in this last area has resulted in Mongolia and Thailand joining the IAU in 2006 and an expression of interest in joining the Union by Bangladesh.

Since there are more than 70 countries where WWDA can usefully operate, the potential exists to double the present activities of this program group from 2 or 3 visits a year to 5 to 6 such visits during the next decade (see Section 3.4).

A.2. Teaching for Astronomy Development (TAD). TAD is intended to assist a country that has little or no astronomical activity, but which wishes to enhance its astronomy education significantly. TAD operates on the basis of a proposal from a professional astronomy organization or on the basis of a contract between the IAU and an academic institution, usually a university. The Chair of the Program Group TAD, with the advice of other members of the PG, presently helps to negotiate a contract so that the proposed activities fall within the financial and managing/supervisory capabilities of the IAU and have a good chance of being realized within a few years. Important elements in acceptance of TAD proposals are the identification of an active local project leader and the potential national importance of the project.

The capabilities of the TAD program are presently limited to assistance with university-level activities, such as the development of astronomy/astrophysics courses, travel grants for visiting lecturers and advice about astronomy education in secondary schools and training of school teachers. Assistance is given for a limited period on the understanding that the cost will eventually be taken over by local institutions.

A.3 International Schools for Young Astronomers (ISYA). This Program Group organizes International Schools for Young Astronomers with the goal of supporting astronomy in developing countries. Typically each school occupies a period of about three weeks. Schools are targeted at about 30 students at academic levels between bachelors and doctors degrees. ISYA seeks to broaden the participants' perspective on astronomy through lectures from an international faculty on selected astronomy topics, seminars, practical exercises and observations, and exchange of experiences. There is a wide regional (multi-country) representation of both lecturers and students. An important goal of an ISYA is to reinforce and to structure the astronomy program in the country where it takes place.

The IAU pays travel and transport of the faculty and all participants. The host institution pays for the stay of the faculty members and all the participants and provides all the facilities for the school. The topics are chosen by the host institution in close collaboration with the Chairperson ISYA. The teaching staff is composed of members from the host institution and outstanding specialists from other countries. The program consists of regular lectures, practical training, seminars, posters, informal discussions and study hours.

Since the inception of ISYA in 1969, 29 ISYAs have been organized in more than 20 countries and have provided education for almost 1000 students. Recent locations include Argentina, Morocco, Mexico, Malaysia and Thailand.

During the next decade the ambition of the ISYA Program Group is to increase the number of regional schools from one per year to three per year (see Section 3.4) and to establish an ISYA Alumni Community.

A.4. Exchange of Astronomers (EA). This program group provides travel grants to qualified astronomers and advanced students for research or study trips abroad of at least three months duration. The visits provide an opportunity to interact with the intellectual life and participate in the research of the host institution. It is the objective of the program that astronomy in the home country be enriched after the applicant returns.

Presently, in a typical triennium, about 20 grants are awarded. The visits are for a variety of purposes, including beginning a graduate program or post-doctoral fellowship, visiting a vibrant research centre such as International Centre for Theoretical Physics (Trieste) or Inter-University Centre for Astronomy and Astrophysics (Pune), visiting an institute to learn new techniques useful for research and education in the home country, and taking up a summer research assistantship.

APPENDIX B
SOME COMPLEMENTARY NON-IAU DEVELOPMENT ACTIVITIES

During recent years several excellent activities specifically devoted to astronomy development and education have been initiated from outside the IAU. Generally these are complementary to IAU activities. We shall here consider a few of the most relevant of these programs.

B.1. United Nations Office for Outer Space Affairs (UNOOSA) is the United Nations office responsible for promoting international cooperation in the peaceful uses of outer space.

Since its inception, UNOOSA has been involved in fundraising efforts to support activities for capacity building in space technology. The Program on Space Applications (PSA) is a UNOOSA program whose mission is to enhance the understanding and subsequent use of space technology for peaceful purposes in general, and for national development, in particular, in response to expressed needs in different geographic regions of the world. Provision of country capacity-building, education, research and development support and technical advisory services by the Program have all helped to reduce the gap between the industrialized and developing countries.

B.2. Planetaria and telescopes - Japanese TRIPOD/ODA Program. In order to promote education and research in developing nations, the Government of Japan has been providing developing nations with high-grade astronomical equipment under the framework of the Official Development Assistance (ODA) cooperation program since 1984. Instruments donated included university-level reflecting telescopes, as well as modern planetaria used for educational purposes, together with various accessories. By the end of 2007 Japan will have provided 7 telescopes and 20 planetaria to 22 developing nations. In order to ensure effective use of these instruments, the Japanese Government provides follow-up technical training through the Japan International Cooperation Agency (JICA). In return, the recipient countries are expected to provide housing and infrastructure for the instruments.

In addition to this program, from 1990 the Japanese ODA has worked closely with the United Nations Office for Outer Space Affairs (UNOOSA) in Vienna and the European Space Agency under the auspices of "TRIPOD", a program to introduce basic space science into research and education at universities in developing nations.

B.3. Secondary education - Hands-On Universe (HOU) is an educational program that enables secondary school students to investigate the Universe while applying tools and concepts from science, mathematics, and technology. Using the Internet, HOU participants around the world request observations from an automated telescope or download images from a large image archive, and analyze them with the aid of user-friendly image processing software. The Lawrence Hall of Science at University of California, Berkeley, is the educational centre for the HOU project.

B.4. Educational telescope network - Las Cumbres Observatory - Faulkes Telescope Project is the education arm of Las Cumbres Observatory Global Telescope Network (LCOGTN), a network of research-class robotic telescopes currently under construction. Currently there are two telescopes, one in Hawaii and the other in Australia, but there will ultimately be many more. These telescopes are available internationally for use by teachers at no cost, as part of their curricular or extra-curricular activities. The network is fully supported

by a range of educational materials and a team of educators and professional astronomers, allowing secondary school students to engage in research-based science education.

B.5. Inspiring very young children - Universe Awareness (UNAWE) is an international outreach activity whose goal is to inspire young disadvantaged children with the beauty and grandeur of the universe. UNAWE exploits the inspirational aspects of modern astronomy to broaden children's minds, awaken their imagination and curiosity in science and stimulate global citizenship and tolerance.
Games, songs, hands-on activities, cartoons and live internet exchanges are devised in partnership with UNAWE communities throughout the world for children from the age of 4 onwards. UNAWE enables the exchange of ideas and materials through networking and interdisciplinary workshops. The program has been adopted as a global cornerstone program of the International Year of Astronomy in 2009. UNAWE is now active in more than 15 countries in Europe and in the developing world, with a team of almost 100 dedicated volunteers.

APPENDIX C

DRAFT PLAN FOR ASTRONOMY EDUCATION AND OUTREACH IN AFRICA: WITH SPECIAL FOCUS ON THE INTERNATIONAL YEAR OF ASTRONOMY 2009

1. Background:

Astronomy is a subject that encompasses a large number of science, engineering and mathematics disciplines. As such it bears a distinct strength in the promotion of these disciplines to students and the public. It is also a subject that sparks the curiosity of young and old alike. In Africa, where education is probably the most sustainable solution to development challenges facing the continent, a group of astronomy-, space science- and education-related individuals and organizations have decided to come together to harness these useful characteristics of astronomy for the benefit of Africa as a whole. In building the astronomy community in Africa, the group aims to use the subject to spark an interest not only in science, engineering and mathematics disciplines, but also in education in general. The International Year of Astronomy shall be used as a launching pad for a network of African individuals and organizations who intend to work together into the future using astronomy to enhance education in Africa.

2. Vision:

The continent of Africa, with an ever-growing astronomy research community, united in the fields of education and outreach, working together and sharing resources, such that the people of Africa are educated, especially in the fields of science, engineering and technology.

3. Theme:

Astronomy for Education

4. Core Missions:

The vision will be realized through the following four core missions (and related objectives), with a focus on building and supporting human resources:

A. **Enhance the teaching and interest in Mathematics and Science in schools through:**
   - A.1. Educational Resource Development and Distribution
   - A.2. Educator Development
   - A.3. Learner Development
   - A.4. Promotion of Astronomy Related Careers

B. **Enhance the teaching and research interest in astronomy in universities through:**
   - B.1. Promotion and encouragement of post-graduate studies
   - B.2. Encouragement and support of physics/astronomy related student bodies
   - B.3. Equipping of universities with necessary infrastructure and resources

C. **Increase the awareness and knowledge of science amongst the public through:**
   - C.1. Public Resource Development and Distribution
   - C.2. Astronomy communication capacity building and implementation
   - C.3. Public programmes and events
   - C.4. Astronomy in the Media

D. **Support and encourage an African network through:**
   - D.1. Sourcing and sharing of astronomy and education related resources
   - D.2. Human resource development
   - D.3. Close liaison with Pan African organizations such as NEPAD and African Union

The following table contains a more detailed description of the core missions:

Target	Objectives	Examples of Actions	Impact
A. Schools	A.1. Educational Resource Development and Distribution	Wide distribution of high quality (curriculum related) resources for educators, learners and educator trainers	Widespread access by schools to high-quality resources
	A.2. Educator Development	Educator workshops, enhanced educator training programmes, incentives, motivational talks	Motivated and capable educators; An expanded team of people promoting astronomy
	A.3. Learner Development	Learner workshops, facility visits, school visits, astronomy clubs	Motivated and capable learners An expanded team of people promoting astronomy
	A.4. Promotion of Astronomy Related Careers	Selected career expos; university student events; talks by scientists/role models; career magazines	Greater interest in and awareness of astronomy and related careers
B. Universities	B.1. Promotion and encouragement of post-graduate studies	Student information sessions; more attractive post graduate funding	Larger number of post graduate students resulting in larger research community
	B.2. Encouragement and support of physics/astronomy related student bodies	Inter-university links and projects through student bodies; Competitions and incentives	Strong student community supporting each other and organized enough to drive big projects
	B.3. Equipping of universities with necessary infrastructure and resources	Sourcing of telescopes for all universities; Equipping libraries with astronomy related books and software	Sufficient resources available to encourage students to study astronomy (or at least science, engineering or maths)
C. Public	C.1. Public Resource Development and Distribution	Posters, popular science magazines, planispheres, telescope kits, flyers	Interest in astronomy generated amongst public and fed by resources
	C.2. Astronomy communication capacity building and implementation	Training for astronomers in communication skills; astronomy training for journalists (science writing); astronomers “on stage”	More astronomers available for media interactions; Greater accuracy of astronomical content in media An expanded team of qualified people promoting astronomy
	C.3. Public programmes and events	Facility tours of carefully monitored quality; public lectures; open nights; star parties; development of visitor centres; off-site activities e.g. “street astronomy”	Generate an interest in and excitement about astronomy amongst the public

B. Universities	B.1. Promotion and encouragement of post-graduate studies	Student information sessions; more attractive post graduate funding	Larger number of post graduate students resulting in larger research community
	B.2. Encouragement and support of physics/astronomy related student bodies	Inter-university links and projects through student bodies; Competitions and incentives	Strong student community supporting each other and organized enough to drive big projects
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C. Public	C.1. Public Resource Development and Distribution	Posters, popular science magazines, planispheres, telescope kits, flyers	Interest in astronomy generated amongst public and fed by resources

5. Structure:

It is recommended that the African network remain an online and dynamic structure with the Pan-African body keeping informed and in contact through email and a website for Africa. Within each country however, is required a driver (single point of contact) along with a team that comprises the steering committee for that country.

6. Guiding Principles:

6.1. Encourage collaboration both nationally and internationally.
6.2. Support and enhance rather than reinvent programmes.
6.3. Ensure adequate monitoring, evaluation and quality assurance.
6.4. Development and support of human resources
6.5. Ensure sustainability at every stage

7. Before IYA2009:

In the time preceding 2009 there will have to be activities carried out in preparation. Some of these activities may require funding of some sort but it is essential to have them completed before the start of 2009:

7.1. Establishment of networks: This will include both collaborative networks amongst the various organizations and individuals as well as a communication network for the dissemination of resources e.g. school clubs network, media network, contacts database, etc

7.2. Consolidation of astronomical resources and best practices: In order to prevent duplication of materials and to ensure effective use of limited human resources, a database needs to be created at a venue that will serve as a "clearing-house" for astronomy resources in

Africa. This database will also be valuable for anyone to use during 2009. During this process a list of "best practices" for astronomy outreach can also be obtained. Each country would be required to consolidate their resources and send to a central database.

7.3 Survey and List of Activities: By June 2008 a survey should be completed with each country submitting details regarding astronomy, mathematics and science education and outreach. From these surveys a finalized list of activities for 2009 should be determined, both local and international.

7.4 Funding for 2009: Funds should be sourced for IYA2009 activities both local and international.

8. During IYA2009

Activities during IYA2009 will fall into one of 4 geographical categories: **global, regional, national** and **local:**

8.1. Global: These projects are essentially driven by the International IAU IYA2009 Working Group and entail participation in global programmes such as GLOBE at Night.

8.2. Regional: Any project specifically involving collaborations between or reach into other African countries are considered to be regional activities. These collaborations may fall under bilateral and regional agreements such as NEPAD or SADC and are encouraged for African development. It is envisaged that these projects would be jointly funded by the national government and the participating countries.

8.3. National: During the course of 2009 there will be various national projects aimed at a group that is spread throughout each country (e.g. a national astronomy quiz, astronomy puzzle in a national newspaper). It is envisaged that these will be funded by the national government.

8.4. Local: These are activities that are targeted at people within a limited area of the country (e.g. a town or province). These activities will be implemented by small groups and it is envisaged that funding would either be provided by the organizations/individuals themselves (implementers of the project) or small grants made available by the national government.

9. After IYA2009

In order to ensure that the impact of IYA2009 has a high degree of sustainability, the following activities need to be carried out in the time shortly thereafter:

9.1. **Global Consolidation of Astronomy Resources:** Many new resources would have been produced during IYA2009 and these should be consolidated and made available to the network for further use in promoting astronomy.

9.2. Regular Astronomy Club/Society Activities: All new astronomy clubs or societies should have a support base in order to ensure regular activities that keep them alive. This support could come from research facilities but would mainly come from well-established amateur societies.

9.3. Regular Communication with the Astronomy in Africa Network: This could take the form of a discussion forum or an e-newsletter that would keep the network active.

9.1. **Universe Awareness Programme:** This programme should be launched during IYA and sustained thereafter through the use of existing networks and incorporation of the philosophy into all astronomy outreach programmes.

9.2. **African Hands on Universe:** Another programme that would bring benefit to African countries.

9.3. **Astronomy in the Media:** There should be a regular media features established during IYA that can be sustained thereafter e.g. daily newspaper column on astronomy, popular television series, etc.

9.4. **Astronomy in the Classroom:** Schools should have been exposed to astronomy during IYA and in the years that follow regular activities should be arranged to keep the motivation alive e.g. activities on solstices, measuring shadows at different times of the year, astronomy in the arts faculty, etc.

9.5. **African Collaborations:** Africa should make maximum use of IYA to build on collaborations with other countries in Africa, specifically in terms of astronomy research and astronomy education/outreach. These should be followed up after IYA with specific projects and programmes that follow the lead that IYA collaborations take.

10. Funding:

10.1. Although funding will be sought from as many sources as possible it is envisaged that the bulk will be provided by the national governments of each individual country. However, an active African network will serve as a motivation for the provision of funding by any potential funders.