Section 1: Survey Papers

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Astronomy for Developing Countries
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Alan H. Batten, ed.

Astronomy for Developing Countries

Alan H. Batten
National Research Council of Canada, Dominion Astrophysical Observatory, 5071, W. Saanich Rd, Victoria, B.C., Canada, V9E 2E7.
e-mail: alan.batten@nrc.ca

Abstract. Developing countries have many claims on their limited resources and astronomy can expect only a small share of a small "pie". A useful rule of thumb is that a country's expenditure on astronomy is likely to be of the same order of magnitude as its per capita Gross National Product multiplied by the number of professional astronomers in the country. In the light of this, we consider how governments of developing countries can help their astronomers, how we can help them and how they can help themselves.

1. Introduction

When I tell friends and colleagues that I am working with astronomers in developing countries, I am frequently asked why such countries should be concerned with astronomy; do they not have many more urgent needs, for example, in the field of public health? I am sure that this is an experience shared by most of those who do similar work and that our colleagues actually working in developing countries are often posed the same question by the more tough-minded officials of their own governments with whom they have to deal. The question is a natural one and most of us must have pondered it ourselves and evolved our own answers to it. Some people point to the industrial spin-off of astronomy. For example, our colleagues in India, building large radio- telescopes, have greatly stimulated the steel and electronics industries of their country, with consequences far removed from their own immediate concerns. Don Wentzel likes to emphasize the versatility possessed by the holders of a modern Ph.D. in astronomy, so that they can make many different kinds of scientific contribution in their home countries. A former President of the IAU, Hanbury Brown, has often stressed the unity of science: you cannot foresee how developments in one area will affect those in quite different areas. For example, tomography is used both in modern medicine and modern astronomy. I am not sure in which field the process was first used but, undoubtedly, developments of it by astronomers have been of use to physicians who have also applied it for their own needs. My own response is to emphasize that most astronomers are also educators and, in that capacity, contribute to a very important aspect of the further development of any country. Most of all, however, the reasons for studying astronomy in a developing country are the same as those for studying astronomy at all. Astronomy is not one of the most obviously practical of human activities although,

historically, it led us to a greater understanding of the laws of terrestrial mechanics and Newton was, in an important sense, a precursor of the industrial revolution. Even more importantly, however, most of us feel that we are, in some sense, more fully human if we learn about the universe in which we live; this was brought out very clearly at another session of this Assembly by Julieta Fierro, drawing on her experiences of teaching elementary astronomy to the street children of México City. There is no reason why only those already privileged to live in wealthy countries should have the additional privilege of feeling more fully human.

2. Some Facts of Life

If that sounds a somewhat idealistic note, let us turn to be quite realistic. We naturally ask "What can people living in developing countries hope to contribute to astronomy and how can the rest of us help them?" Perhaps a better question would be "What proportion of its resources should any country devote to the study of astronomy?". Let us begin by reminding ourselves how few astronomers there are. A recent ICSU document contains the estimate that there are somewhere between three million and ten million scientists in the world (Arber, 1999). Those figures exclude engineers, social scientists and people working in clinical medicine. If we take six million as a useful order-of- magnitude number, something like one person in every thousand is a natural scientist of some kind although, in developed countries, the ratio can be as high as one in a hundred. We all know that astronomers are a small fraction of the total number of scientists. The membership of the IAU is of the order of ten thousand. Even allowing for the fact that there are many astronomers not in the IAU, less than 1 per cent of all scientists, or less than 10^{-5} of the total world population, are professional astronomers. Yet, increasingly, we are asking for large and expensive instruments with which to pursue our research; instruments that cost, in total, billions of dollars. Even though the world's astronomers are concentrated in the wealthiest countries, few nations are now prepared to pay all the cost of these instruments from public funds and, unless private funds are found, only international consortia are building the world's largest instruments. Canada is about average in numbers of astronomers, in that about one person in every 10^5 is a professional astronomer, yet the instruments we have built, or our share in international instruments, have typically cost about 10^{-4} of our Gross National Product (GNP). Although I have deliberately focussed attention on professional astronomers, I recognize that in many countries – Canada included – there are amateurs who are making real contributions to the science, especially through such organizations as the AAVSO, who certainly support the devoting of a considerable share of national wealth to the study of astronomy and who can also play a role in helping astronomers in developing countries. In some of those countries, however, social and economic conditions prevent the emergence of a group with leisure enough to become amateur astronomers and it is difficult to make fair comparisons between developed and developing countries that take into account the contributions that many amateurs make.

To return to budgetary matters, the capital cost of instruments is nearly always spread over several years; a closer examination of the astronomy budgets

of many countries shows that the per capita GNP, multiplied by the number of professional astronomers in a country is a rough indication of the annual budget for public funding over a period of years. By "rough", I mean that the annual budget will not be more than a few times the product of the other two quantities. This is illustrated for a number of countries, including several in the G8, in a recent Canadian report (Pudritz, 1999). (That report more correctly uses the Gross Domestic Product – GDP). I have chosen to use GNP because the source available to me provides the per capita figure for that quantity for every country; the principle of the argument is not greatly affected by this choice.) Even so, several provisos are needed. In some countries it is difficult to separate astronomy budgets from space-science budgets; in others, it is unclear whether university astronomy is included in public funding of astronomy or in the general university budget. In all countries, of course, it is often uncertain just how many astronomers there are, since there are various ways of defining who is an "astronomer" and, as already mentioned, the role of amateurs differs widely from one country to another. Provided we are content with order-of-magnitude estimates, however, we will find that the product of per capita GNP and the number of astronomers will give some idea of what we might expect the annual expenditure on astronomy to be; rarely will the annual expenditure exceed ten times the product of the other two quantities. Whether or not that product really tells us how much a country should spend on astronomy, it at least provides a yardstick for estimating any given country's probable actual public funding for the field.

We immediately notice the shocking disparity in per capita GNP between the world's richest and the world's poorest countries; it is worse than appears from Figure 1, which condenses the wealthiest countries into one bin; the disparity is a factor of several hundred. Our colleagues in the developing countries suffer from two disadvantages: their per capita GNP is lower and so is the number of astronomers, if not absolutely then in relation to the total population. Let us take an imaginary country with a per capita GNP of U.S. $200 and employing five astronomers. I stress that this *is* an imaginary country, but it is not a fantastic one; some of the people who attended the Special Session in Manchester came from countries in which the situation is not very different. The formula given above implies that the annual budget for astronomy (including the salaries of the five) is going to be a few thousand U.S. dollars; if they are very lucky, perhaps as much as $10,000. Let us stop to think of the implications. Equipping each astronomer with a computer could absorb more than a whole year's budget! The smallest telescope with which useful research can be done (a 40-cm reflector) will likewise absorb more than one year's budget –even before any auxiliary instrumentation is bought or suitable housing for the telescope is constructed. Journal subscriptions are going to make a big hole in the budget, unless the journals themselves provide relief – as many do (Abt 1998). Only a few books can be bought and personal travel by the astronomers, whether to go to meetings or to observe, is almost out of the question. This should give those of us in wealthy countries some food for thought the next time we are tempted to complain about our budgetary restrictions! It is no use expecting people working in developing countries to pay for some of these things out of their salaries because, in fact, per capita GNP is quite a good indication of average family earnings. That does not mean that our colleagues live their daily lives in poverty, since basic needs

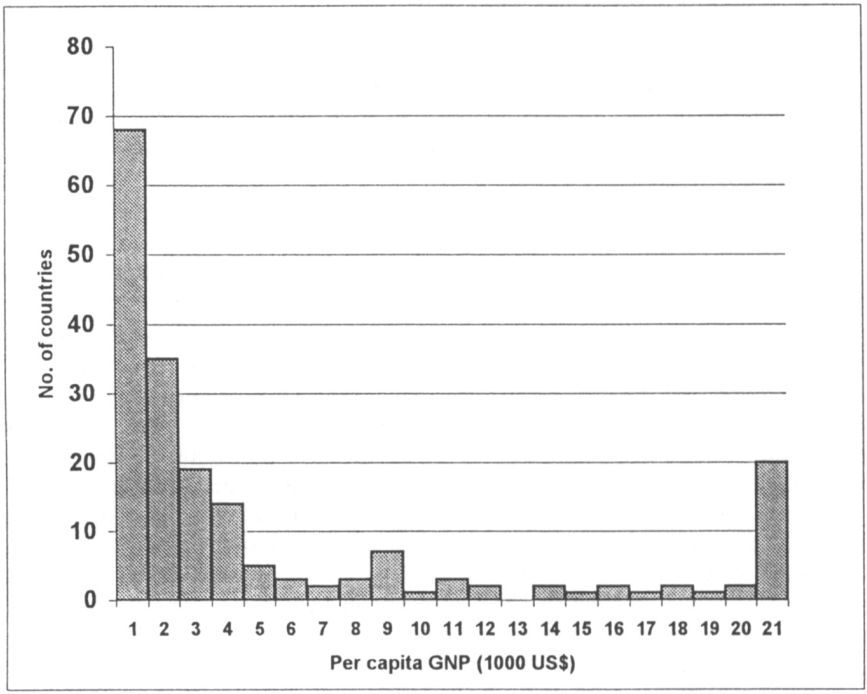

Figure 1. Distribution of 193 countries by per capita Gross National Product in recent years. Abscissae are the per capita GNP (not necessarily for the same year) expressed in thousands of U.S. dollars; ordinates are the numbers of countries in each interval. For convenience, all countries with per capita GNP in excess of U.S. $20,000 are condensed in one bin. Source: *Encyclopaedia Britannica Book of the Year* for 1999.

provided within the country are cheap by the standards of developed countries, but it does mean that travel, journals, books, computers and instruments – all of which have to be paid for at the international "going rate" – are as out of reach for them personally as they are for their institutes. Possibly a country for which the proposed formula predicts an amount so small that no useful work in astronomy can be done at all should not encourage the study of that subject; in fact, few do, but the decision must remain one for the country itself to make, in the light of its circumstances and its own perception of its needs.

Compare the above with the situation of my colleagues in Canada. We have 300 to 400 active professional astronomers and a per capita GNP of around (U.S.) $20,000. We expect, then, that public funding in Canada is going to be of the order of $\$10^7$ annually and that is indeed the case, when capital expenditures are included. Put another way, Canada is providing each of its astronomers with some tens of thousands of dollars annually (over and above their salaries). We are by no means the world's wealthiest country, and we have a reputation of being among the low spenders on scientific research (relative to GNP), in

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comparison with the other G8 countries. There are certainly countries whose astronomers are even better off.

3. What can Governments do?

In drawing attention to the disparities between countries, I am in no way trying to criticize the governments of developing countries or, indeed, of any country; rather, I am trying to convince those of us from the developed world how fortunate we are; something we can very easily forget, unless we make a conscious effort to remind ourselves. To avoid the appearance of criticizing particular regimes, I will, as far as possible avoid naming individual developing countries in this paper, but I remember one colleague, of about my own age, telling me that to work in the West, as he had briefly done, seemed to him like being in paradise! The situation has changed for the better, in many respects, in his country now, but those of us in wealthy countries are still immeasurably better off. I have no doubt that, if I were a government official in a developing country, I would have to draw the attention of would-be astronomers to the "facts of life" discussed in the previous section. Hard choices have to be made in the allocation of funds and we all must be realistic enough to accept that. On the other hand, there are non-financial constraints that governments could do something about if they wished. "Red tape" is often much more obvious in developing countries. For instance, on leaving one such country, I was required to show my passport four or five separate times at the airport. For a short-term visitor, such repeated checks are no more than a minor irritant and can, perhaps, even be amusing; those who are up against similar attitudes every day in their work must find them frustrating and, sometimes, infuriating. I have, for example, heard accounts of how access to university offices is restricted, or even forbidden, "out of hours". No doubt, government officials could offer convincing reasons for this kind of regulation. There are fears for the security of buildings and equipment (Onuora 2001, Snowden 2001). I know of at least one country in which the observatory is provided with an armed guard, twenty-four hours a day. There are also needs to create employment and, unfortunately, to forestall corruption by elaborate checks and counter-checks. The kind of bureaucratic attitude that these checks inevitably engender, however, is definitely inimical to an atmosphere in which good scientific work can flourish. Even worse, authoritarian governments will sometimes put their interests in controlling their populations above the free exchange of scientific information. I have been in at least one country in which I was told that provision for e-mail was in the astronomy budget but the astronomers could not have it, for political reasons. The regime in that country has changed since my visit, and the astronomers have e-mail now, but it is quite understandable that some governments should fear a medium of worldwide communication that they cannot censor. When such a fear results in a government deliberately restricting its own scientists from free communication with colleagues in other countries, however, those scientists are automatically condemned to second-rate status. Those of us who are more fortunate should take every opportunity to stress that governments that really want to encourage home-grown science can go a long way to achieving their end without much financial cost, if they will consciously try to create the conditions

in which science flourishes, and, in particular, if they will relax restrictions on communication.

4. What can Astronomers in Developed Countries do?

It is clear from all that we have considered so far that, if there is to be any astronomy in developing countries, there must be help from outside; financial help, of course, but, just as, if not even more important, the help of fellow astronomers who care about their isolated and less fortunate colleagues. This, I think, is clearly recognized in many quarters and the IAU has actually quite a good record of helping, considering its own limited financial resources. Those of you who took part in Joint Discussion 20 in Kyoto three years ago will have some idea of what the IAU has done, and is doing, along these lines; those of you who were not there can read about it in the account of that meeting (Batten 1998). We are not the only organization; the UN/ESA international workshops (also supported by The Planetary Society) have been very important and there are many who can testify to the help that they have received from the Vatican Observatory Summer Schools which, along with other similar initiatives, are described in more detail in this volume (Corbally 2001). It is particularly appropriate, in the record of a meeting in the University of Manchester, to mention that Zdeněk Kopal, for three decades Professor of Astronomy at that University, enabled many people from developing countries, particularly those in the Middle East, to go there to pursue studies up to the Ph.D. level and that most of those are now working in their home countries. He would, I believe, have been delighted that this meeting should have taken place there and that one of his earliest Manchester students should have organized it. I am sure that there are several other instances of particular individuals or institutes helping in such ways, but the majority of our colleagues in the wealthy countries do not seem greatly concerned about how their less fortunate colleagues might be integrated into the world community of astronomers and have not fully informed themselves about the conditions under which those colleagues work. One of the most important things we can do, and that I hope the meeting and its published proceedings will do, is to raise consciousness in the rest of the community about the needs of astronomers who work under much less ideal conditions than those of us in the most favoured countries enjoy.

I have emphasized the lack of computers, instruments, books and journals in the preceding sections but, of course, there are people working to alleviate these conditions. For example, the Japanese Government's programme of donating telescopes of about 40-cm diameter to selected countries has already made a difference in several, as will also Querci's Project NORT programme as it develops (Querci 1995). There is a need, however, as is also brought out elsewhere in this volume (Snowden 2001, Wentzel 2001), for continuing cooperation with the international community to ensure that these generous gifts are used to their maximum capacity. Similarly, I know that the UN/ESA International Workshops have often been the means of introducing a number of computers into countries that otherwise would not have had them so soon. There are likewise several programmes for transferring books and journals to poorer countries (Hingley 2001). One problem about these programmes is that they usually rely

on gifts of personal libraries made by retiring astronomers at the ends of their careers. One hesitates to criticize, even mildly, such generosity, but an inevitable consequence is that the books and journals sent are out of date. The crying need is for modern material; colleagues might well consider sending their personal issues of a journal to some institute in the developing world as soon as they have finished with them – or at least at the end of a calendar year.

Ultimately, however, the real problem faced by astronomers in developing countries is that of isolation – not only literally or geographically, but intellectually as well – and that is where any one of us can help. In a few countries, those which happen to have good potential observing sites, that isolation may be quite quickly broken down. Not many years ago, ESO had to renegotiate with Chile the contract under which it operates in that country (the anonymity of which cannot be preserved in this example), and the new contract had some very favourable terms for the local astronomical community written in (Mervis and Abbott 1993, Abbott 1993). However delicate and difficult those negotiations may have been at the time, that they were needed at all was a clear indication that ESO, and the other international observatories in Chile, had played a considerable role in reinvigorating the Chilean astronomical community and, indeed, those of other Latin-American countries. Similar developments could occur elsewhere. I have seen for myself the potential of the Atlas Mountains in North Africa and there may be similar opportunities in Central Asia, in countries that were formerly part of the Soviet Union (Babadzhanov 2001). That kind of development, however, is open only to a few naturally favoured countries. Many, if not most, developing countries do not have observing sites with the potential to attract the international consortia that build large telescopes.

Another route to minimize the effects of isolation is to encourage regional cooperation as, indeed, the IAU has done with its regional meetings. Of the two continuing IAU regions, however, one, Latin America, is reasonably compact, whereas the other, the Asian-Pacific region is rather large and amorphous. One can envisage several smaller regions in which astronomically advanced countries like Australia, New Zealand, Japan, China, India, Indonesia and Korea can act as centres for smaller nearby countries. This sort of thing is happening on a limited scale and should be encouraged (Kaifu 2001). Africa is a special case, but the establishment a few years ago of the UN Working Group on Space Sciences in Africa is an encouraging development. The complete political change in South Africa has removed barriers that once existed to cooperation between the internationally respected astronomical community in South Africa and communities in other African countries, but the great size of the continent and the difference in character between the countries on the Mediterranean coast and those south of the Sahara suggests that North-African countries should be more usefully linked across the Mediterranean, as is, in fact, beginning to happen. Southern Africa, on the other hand, is one of the regions where very favourable observing conditions are to be found and the planned construction of the Southern African Large Telescope (SALT) holds great promise for increasing regional cooperation on that continent, as is also described in this volume (Martinez 2001, Rijsdijk 2001, Hemenway and Preston 2001).

Grand schemes of regional cooperation have their place but, eventually everything depends on individual contacts, or at least on contacts between in-

dividual institutes. The great aim should be to enable the young astronomers in developing countries who have received a full modern education in astronomy to keep their contacts with the developed world and, above all, to take part in modern research, whether theoretical or observational. We all know that some modern research can, and should, be done with small instruments, but the young astronomer who has had a taste of working on a 4-m or larger giant telescope to obtain material for a Ph.D. thesis is likely to want to repeat the experience and to continue to work in fields in which such large instruments are necessary. Even among the astronomers in the developed world, it is now the exception for an individual to be awarded significant amounts of observing time on such instruments; rather, groups of half-a-dozen or more pool their expertise and compete for time with other similar-sized groups. We need a way for astronomers in developing countries to find acceptance in such groups and to take part in the reduction and analysis, if not in the actual collection, of the data. This means that astronomers who have studied in a developed country and returned home need to keep in touch with the respective institutes at which they studied (or perhaps held a post-doctoral fellowship). It means also that those former students must be able sometimes to return to those institutes for a period of months, to be refreshed by contacts with their former associates. Almost certainly, such return visits will be at the expense of the institute concerned. Are the more fortunate of us prepared to give up a few trips a year to make such return visits possible? In the end, we must give up something; I have tried to show how much more fortunate we are, and if we have to give up one meeting a year to bring one colleague over to us for a summer, the sacrifice is small but well worthwhile.

Many colleagues in the developed countries are convinced that the best way to help is by sharing the electronic data bases that we now have. Astronomers in developing countries, it is argued, can have access to these bases and work with modern data on modern problems. These possibilities are also elaborated in this volume (Helou 2001, Malkov, Tutukov and Kovaleva 2001, Ratnatunga 2001) and we should certainly be aware of them, but there are still practical difficulties. Having an e-mail address, or a fax number, do not in themselves guarantee access to the desired communication. Seven years ago I was in a country with a very inefficient telephone service. Calling outside the country was almost impossible, and, even to place a call across the principal city, one had to be prepared to try several times. While I was at a meeting there, a visiting representative of a European telecommunications company assured us that soon all would be well. A new kind of switch was to be imported very soon and everyone would enjoy complete access to the Web. Before the meeting in Manchester, I heard that the astronomers of that country were just getting e-mail but, as I learned in Manchester, access to it is at their own expense! More generally, e-mail connections seem to be less reliable in developing countries and fax machines often fail. I would not like to count the number of times I was frustrated in the organization of this meeting in attempts to reach would-be participants. Fax machines appear often to be switched off at night, and longitude differences then ensure that the machines are not accessible from North America at any reasonable hour. For a period of several weeks, colleagues in one country could not be reached because a lightning storm had knocked out the computer system on which they depended for e-mail. This could happen in

any country, of course, especially in the tropics, but the damage is likely to be much more quickly repaired in a developed country – a point which is made very strongly in this volume (Onuora 2001). Even if all these problems are overcome, it is still necessary for the individual astronomers to have access to and to be able to use the sophisticated data-processing programs that are required to handle modern data properly – yet many colleagues presenting papers at this meeting told me that they could not make use of the LaTeX template provided for the preparation of their abstracts. Here again, there is need for a continuing relationship between individuals in developing countries and specific institutes in the developed countries; or at least for some cooperative organization in developing countries such as is envisaged in Narlikar's scheme for a Third-World Astronomy Network (Narlikar 2001).

5. What can Astronomers in Developing Countries do for Themselves?

It may seem surprising to suggest that astronomers placed in the sort of circumstances I have described can also help themselves, but I believe it to be true. One very simple thing that all astronomers in developing countries could do to help themselves, for example, is to be more punctilious about responding to the messages that do reach them. As mentioned above, I was often frustrated in the preparation of this meeting by unanswered queries and I do not believe that all these instances are to be blamed on the difficulties under which colleagues in developing countries often work and to which I have referred. Modern means of communication make possible effectively instantaneous communication around the world. On the west coast of Canada, for example, I can sometimes receive a reply from New Zealand within minutes of sending a question, even though (or perhaps because!) the New Zealanders' calendar date is day ahead of mine. Replies from most of Asia, of course, are delayed because their night-time hours coincide with my daylight ones, and none of us checks our e-mail every day. Even so, I often find a reply from Japan awaiting me on the morning after I send a query. This efficiency in communication becomes possible, however, only if the human being who uses the computer is prompt in replying.

There are other, perhaps more important, ways in which astronomers in developing countries can help themselves. As I have already implied, in many countries a necessary first step in the development of astronomy is sending promising students abroad for advanced studies. For various reasons, mostly either directly or indirectly the legacy of former colonialism, people of my generation in newly independent countries have often been cut off from modern astronomical research for much of their lives. They are unable, and in my experience freely admit that they are unable, to educate the new generation beyond imparting the very basic elements of the subject to them. I have also observed that the new generation is frequently impatient with their elders – which is an understandable reaction, not confined to developing countries, but particularly unfair in the context I have just described. The older generation, after all, did keep the torch burning, sometimes at great personal cost; they deserve a great deal of honour for doing what they could do in the situations in which they found themselves. Other papers in this volume discuss the potential of distance-learning for

alleviating this situation (Jones 2001) but, sooner or later, graduate students need the personal contact with senior workers and fellow-students that can, as yet, come only through physical presence in a major institute. Some nations are understandably anxious about sending their most promising students abroad; will they return? This is a real problem; I received my graduate education in Manchester and, one year later, left for what I thought would be one year in Canada where, forty-one years later, I still live; so I know very well what the temptations are! The problem is perhaps not as great now as it was in my day, since all countries are having difficulty finding positions for their own science graduates, and the wealthy countries are not so ready now as they once were to "steal" graduates from poorer countries to make up their own shortfalls. The way for developing countries to encourage the return of graduates is not so much to attach conditions to their departure (which can often be got around by those determined to emigrate permanently) as to create conditions in which they will be able to use their newly obtained skills back in their own country. Most young people are both idealistic and patriotic and will work for, and in, their native land if they can see some chance of building up a scientific tradition there. While the provision of modern equipment may genuinely be beyond the present resources of many developing countries, as I have already said, much can be done to create working conditions congenial to scientists, at very little financial cost.

What has all this to do with how the scientific community in a developing country can help itself, without waiting for the politicians and bureaucrats to act? Just as the younger generation, in countries that have gone through decades of unrest or even outright civil war, should realize that their elders have often made great sacrifices to preserve any scientific tradition at all, those same elders must be ready to give their former students great freedom in choosing the fields in which they work and in their manner of doing that work. In the nineteenth century, an observatory director, in any part of the world, was "boss" – and could be a petty tyrant. All other scientists on his staff (and they *were* all male then!) were his assistants and his name usually appeared as first author of any paper that was published. When observatories were founded in countries that were then ruled as colonies, the same attitude was brought to them. In modern Europe and North America, this system is no longer in operation; it does not work in the modern world. You cannot give students all the education required to complete a modern Ph.D. and then expect them to act as assistants. They have been taught to think and to act independently. So, if a you, a professor in a developing country, have sent your most promising student to another country to get a modern astronomical education, then you must not expect that student to return simply to act as your assistant. If you try, the student will probably leave again at the earliest opportunity; and that is precisely the result that none of us wants.

It is also important for the few astronomers there are in any developing country to work together. I have seen instances of astronomy beginning (or at least reviving) in a country in which a small number of astronomers have coalesced around two or three institutes which then begin to compete for the very little funding there is. This can be fatal in any country. Even in Canada, a generation ago, astronomers had a fierce quarrel about the location of a major new instrument and the government of the day very quickly withdrew the

promised funding, because we could not agree about what we wanted. If this can happen in a country with a tradition of astronomical research and, as I have shown, relatively generous funding of it, how much more easily can it happen in a country without such a tradition and with many competing claims on the public purse! In one of the countries that has been most successful in creating an indigenous tradition of astronomy after returning to independence, it has been a deliberate policy to build up only one centre, until that became well-established, before encouraging the growth of the subject in other centres. Thus there was no rivalry between institutes at the time at which the progress of astronomy would have been most vulnerable to disagreements among the astronomers.

The situation of astronomers in developing countries is likely to remain a difficult one for some years, possibly some decades, to come. Unfortunately, the poorer the country, the longer it is likely to be before any astronomers in it can hope for improvement. I have tried to make suggestions, however, of things that can be done to mitigate that plight – often at very little or no financial cost. Mitigation, however, does require of at least some of us, both in developing and developed countries, a change of attitude. Those of us who are fortunate enough to live in countries in which we can achieve a great deal of what we hope for need to give up the competitiveness which has, unfortunately, crept into astronomy in the last several decades and be prepared to achieve a little less if, by doing so, we can give a helping hand. Those of you who are struggling all the time with the problems of no money and intellectual isolation must also be prepared to cultivate attitudes of mind that, maybe, do not come naturally in the culture in which you have grown up. Governments of all kinds must come to accept that their job is not only to control their citizenry but also to serve it. If we all try to work together, there is still hope that astronomy will not only survive in developing countries, but also flourish.

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Discussion

Dworetsky asked if there was documentation for the industrial spin-off of astronomy in India (apparently there is not). Dworetsky also wondered what argument one could present to a minister in a developing country for the support of astronomy. Martinez suggested that astronomy draws young people to careers in science and technology and that these people will eventually build up the science-and-technology base in developing countries. Ericson asked how could telescopes of 10-cm to 30-cm aperture produce useful results. He also wanted to know how we could fund temporary visits to developing countries by astronomers and astrophysicists from developed countries.