*Statistical Science*
2003, Vol. 18, No. 4, 481–488


# A Conversation with Abdel H. El-Shaarawi

**Sylvia R. Esterby**

*Abstract.* Abdel El-Shaarawi was born on December 31, 1942, in Zagazig, Egypt. He received his B.Sc. and M.Sc. degrees in 1964 and 1968 from Cairo University and his Ph.D. in Statistics in 1973 from University of Waterloo. In 1973 he began a career as a research scientist at the Canada Centre for Inland Waters in Burlington, Ontario. He has been part-time Professor in the Department of Mathematics and Statistics, McMaster University, since 1980, and Adjunct Professor in the Department of Statistics and Actuarial Sciences, University of Western Ontario, 1986 to 1996, and in the Department of Statistics, University of British Columbia, since 2001. During 1983–1984 he was Visiting Professor at the University of Metz and during 2002–2003 at the University of Genoa. For shorter periods he has been Visiting Professor at the University of Kuwait (1998, 1999), Masaryk University (1998, 1999) and King Saud University (2000). He is founding Editor of the journal *Environmetrics* and founding President of The International Environmetrics Society. He is an elected member of the International Statistical Institute and a Fellow of the Royal Statistical Society (United Kingdom), the American Statistical Association and the Modelling and Simulation Society of Australia and New Zealand. Awards include the Distinguished Achievement Medal of the ASA Section on Statistics and the Environment and the Citation of Excellence Award from the Government of Canada.

*Key words and phrases:* Environmetrics, The International Environmetrics Society, pollution control and regulation, applied statistics, multidisciplinary research.

**Esterby:** Let us proceed chronologically with your roots in Egypt and your education. Could you tell us about your family, childhood and pre-university education?

**El-Shaarawi:** I was born in the village of Kafr Abaza, a suburb of Zagazig (the capital of El-Sharquia province), about 60 km northeast of Cairo. My father was a teacher and my mother was a housewife. My parents had ten children (five boys and five girls) and they considered their main mission to be the education of their children despite their limited resources. To manage the costs of education and raise a large family, the family cultivated a small plot of land and raised small farm animals. Of course we had to help. I attended the village school for primary education, but had to move to Zagazig for preparatory and secondary schooling.

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## UNIVERSITY OF CAIRO AND UNIVERSITY OF WATERLOO

**Esterby:** Your next move was to Cairo and to university. What led you to choose statistics?

**El-Shaarawi:** It was really an accident that I ended up as a statistician. After high school graduation in 1960, I enrolled in the Faculty of Medicine following the wishes of my family. However, it was clear to me that medicine was not the right choice since I don't like to see suffering and because of the higher costs and longer time to graduation. I decided to change direction and transferred to the newly established Faculty of

Economics and Political Science (FEPS) at Cairo University. There were three departments in FEPS: Economics, Political Science and Statistics. In the first year, there were only 150 students, with admission to this faculty granted to high school graduates on the basis of top marks across the country. The faculty was like a small community, with good interactions among the students and between the students and the professors. All courses were compulsory but there was sufficient coverage to allow a student to select a specialization by joining one of the three streams.

I joined the Statistics Department of FEPS, which had fewer than 15 students. Professor Madany D. Mustafa was the Head of the Department and we had many of the eminent Egyptian statisticians as faculty members, including the late Professors Abdel Moneim El-Shaffiee and Salieb Rafael, and also Professors A. El-Badrey and A. E. Sarhan. The low student-to-professor ratio resulted in an excellent educational experience. During the last three years of the B.Sc. we were exposed to a wide range of statistical and mathematical topics. Most applications were centered on demographic, agricultural, economic or political science problems. There was a good balance between theory and applications, which showed the importance of statistics, not only as a discipline, but also in daily life.

**Esterby:** You have research interests that go back to your days as a Masters student at the University of Cairo.

**El-Shaarawi:** After graduation in 1964, I worked as an instructor at Al-Azhar University, where I taught statistics and mathematics. When FEPS began a graduate program in statistics in 1966, I enrolled and subsequently obtained my M.Sc. in 1968, as the first graduate of the program. The first year was devoted to graduate courses and the second to writing a thesis. My thesis supervisor was Salieb Rafael and the topic was on the analysis of nonorthogonal factorial designs, where an orthogonalization technique was developed for inverting large structured matrices. These were required for the inversion of a 60-by-60 matrix in the analysis of an agricultural experimental data set. This was a major problem when we had only hand computing machines and it was difficult to have access to the IBM 1620 computer, which was housed at the National Planning Institute. We were lucky to have some eminent statisticians visiting the university and offering series of lectures and short courses. I fondly remember taking a course on probability from Ralph Bradley and a course on experimental design from Gertrude M. Cox.

**Esterby:** You have already mentioned that during your B.Sc. the courses provided a good balance between theory and applications. Would it be correct to say that statistics was already a well-established discipline in Egypt?

**El-Shaarawi:** The year 1960 is of great significance for statistics in Egypt, because the first statistics department established in Egypt was the Department of Statistics in FEPS in Cairo University. Prior to that statistics was taught in the mathematics departments in the universities. With this new department, students were able to specialize and obtain a bachelors degree in statistics, and as mentioned, the graduate program followed in 1966. In addition, the Egyptian Statistical Institute was offering training courses to postgraduate students. The scope of statistical activities was largely connected to the needs and activities within the country. For example, demographics, official statistics and agricultural statistics were major activities. These were important when the country was using central planning as its vehicle for economic development. I think this demonstrates that the answer to your question is yes.

**Esterby:** Was travel abroad necessary to pursue a Ph.D. at that time at the University of Cairo?

**El-Shaarawi:** After completing my M.Sc. in 1968, I began my Ph.D. in the same department. The topic was Decentralization of Decision-Making, which is a topic in econometrics. However, at that time other students were going abroad to study and I felt it would be more fruitful to pursue my Ph.D. where I would be exposed to other schools of thought and other cultures. I was granted a government scholarship to study in the Soviet Union and started making preparations to leave by studying Russian in the Soviet Cultural Center in Cairo. A few months before departure for Russia I was advised by colleagues and professors to try for a fellowship in a Western country. After several applications to Canadian and U.S. universities, admission with support came from the Department of Statistics at the University of Waterloo.

**Esterby:** The period during which you were a student at the University of Waterloo was a time of expansion for the department and there were many visitors to the department. Can you tell us about the department during this time?

**El-Shaarawi:** I arrived in Canada on September 29, 1969, and noted a fully different world from the one left behind. Waterloo was a cosmopolitan university

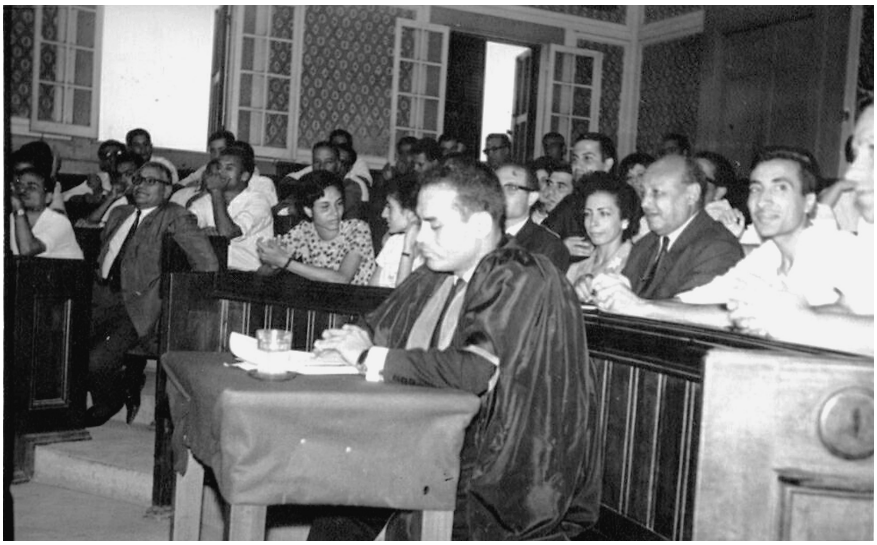

FIG. 1. *M.Sc. thesis defense, University of Cairo, 1968. The examining committee, Professors Madany D. Mustafa, Salieb Rafael and an external examiner from Ain Shams University, Abdel-Azim Anis, sat facing the candidate and are not shown. The audience included faculty, students and family, with the Dean of Commerce at Al-Azhar University, Lotfie El-Essoie, in the first row to the left of Abdel. Just behind and to the right is Nadia Makarrey, recently returned from Iowa State University to an assistant professorship in the department.*

with students coming from all over the world. The Department of Statistics had an energetic faculty, with a high proportion of young faculty members. There was a regular weekly seminar series and the University had excellent computing facilities and libraries. Famous statisticians who gave seminars, taught short courses, and gave lectures in the regular courses frequently visited the department. Foundations of statistical inference and biostatistics were areas of special interest. For example, I attended short courses delivered by Joe Gani and Marvin Zelen, who both visited the Department on an almost regular basis. I also recall the 1970 conference on the Foundations of Statistical Inference (1971 Proceedings by V. P. Godambe and D. A. Sprott) in which Jerzy Neyman, George Barnard, David Cox and D. V. Lindley participated, as well as a number of other statisticians who have shaped statistical inference. It was interesting to be a witness to the vigorous debates among the proponents of various schools of inference.

I completed the required graduate courses, passed the comprehensive exam and began to work on my thesis under the joint supervision of W. F. Forbes and Ross Prentice. Ross had just finished his Ph.D. with Don Fraser at the University of Toronto and joined Waterloo as an Assistant Professor. I was particularly close to Ross, who really was a friend and who always provided guidance when needed. The late Professor Forbes at that time was very busy for he was the Dean of Mathematics and the supervisor of many students. Kirti Shah was another professor who influenced my research. I finished my Ph.D. work in 1972. The thesis topic was in the area of biostatistics and included the study of regional variations in mortality rates in Ontario for different causes of death, associations of mortality rates with environmental and anthropogenic factors and the discrimination between aging models. It involved work on linear models and marginal likelihood. Several papers were published from the thesis, some in statistical journals and others in medical journals (El-Shaarawi, Cherry, Forbes and Prentice, 1976). I also published papers on mixed linear models, and partial linear models. These were published in *JRSS-B* and *Sankhyā* (El-Shaarawi, Prentice and Shah, 1975; El-Shaarawi, 1977; El-Shaarawi and Shah, 1980).

## WORKING IN THE ENVIRONMENTAL SCIENCES

**Esterby:** After graduation you went to the Canada Centre for Inland Waters (CCIW), now the name of the research building in Burlington, Ontario. However, at that time CCIW was the name of an organizational unit within the Federal Environment Department concerned with fresh water research. The move to CCIW provided a number of areas for collaboration. What were the most interesting problems that you worked on in the early years at CCIW?

**El-Shaarawi:** When I started working at CCIW in 1973, I was struck by the complexity of the relationships between the physical, chemical and biological

factors that need to be understood in order to make rational decisions for the protection of the Great Lakes from pollution. At this time, CCIW was only six years old, and from the beginning the Centre devoted most of its resources to the acquisition of data pertaining to the Great Lakes and the connecting channels between them. There were scientists from almost all disciplines, but the thought of employing a statistician had not arisen until I was hired.

In the early years, eutrophication was declared to be the disease of the Lakes, and the disease that had killed Lake Erie. It was also declared that phosphorous was the prime cause of the problem and that it must be controlled. So I was involved in various aspects of data analysis, especially in the study of intra- and inter-lake variations and how they evolve in time (El-Shaarawi, 1987a, 1993). For example, I developed a system for the classification that divided a given lake into "homogeneous" regions or zones for the purpose of improving the design of data collection and the reporting of water quality status. Later, when the primary concern shifted from eutrophication to other issues, particularly toxic substances, I developed methodologies for estimating trend in input loading and concentrations of various pollutants in the Niagara River and Lake Ontario (El-Shaarawi, Esterby, Warry and Kuntz, 1985; El-Shaarawi, 1987b, 1989). These methodologies have been adopted by the U.S. and Canadian governments for reporting progress in the control of toxic substances to the Niagara River, as required by the 1987 Declaration of Intent between the governments of the two countries. Clearly, the performance of my job has required a great deal of interaction with my fellow scientists within and outside CCIW. This had a profound impact on shaping my views about the scope of the statistical profession.

**Esterby:** These early collaborations opened up other opportunities outside of CCIW, some international.

**El-Shaarawi:** Yes, they did, initially in Canada, with different organizations in the federal and the provincial governments. You were involved in some of these activities, such as giving short courses, or developing a procedure for performing a specific type of analysis such as trend analysis or estimation of contaminant loading.

The involvement at the international level was quite extensive and took various forms. For example, I was involved in designing the 1983–1984 survey for assessing temporal and spatial changes in drinking water quality in the City of Metz, France. I was a member (the only statistician) of the U.S. Committee on the revision of water quality standards (1984–1985), a reviewer of the Canadian and U.S. acid rain program and a consultant for the study of environmental effects related to the Extremely Low Frequency (ELF) U.S. Navy Communication System (1992–1997). In quite a different area, I was a member of the NASA–Haystack Review Panel for evaluating the risk from space debris. Over longer periods, I was an advisor for more than ten years to the Canadian International Development Research Centre (IDRC) on its extensive projects in developing countries, including countries in Asia, Africa and South America, and a consultant for the World Health Organization (WHO), World Bank and Canadian International Development Agency (CIDA) on water quality projects in many countries.

**Esterby:** You organized a number of conferences at CCIW, starting with the Conference on Time Series Methods in the Hydrosciences in 1981. What was the impetus for organizing these conferences and the interest in the conferences from within and outside of the statistical community?

**El-Shaarawi:** It was the realization that statisticians must become effective partners with other scientists and decision-makers in dealing with environmental issues. You were a coeditor of the proceedings of the first conference "Time Series Methods in Hydrosciences" (El-Shaarawi and Esterby, 1982). The topics of this conference were specifically selected because of the well-established recognition by hydrologists of the contributions made by statisticians to their science, particularly to water quantity issues. The idea was to provide a forum in which to introduce the participants to some aspects related to water quality problems. That year I proposed to Elsevier the idea of establishing the *Environmetrics* journal, but they were only interested in publishing proceedings.

The second conference, Statistical Aspects of Water Quality Monitoring, was held in 1985, and the third, Workshop on Statistical Methods for the Assessment of Point Source Pollution in 1988. These were also held at CCIW in Burlington, with each conference targeting the statistical aspects of a specific environmental issue. The first conference attracted more statisticians, since statistics was better established in the area. The later conferences attracted more subject-matter scientists than statisticians, which seemed to imply that there were not many statisticians actually working in these areas.

## ORIGINS OF TIES AND *ENVIRONMETRICS*

**Esterby:** Did the first conference in the series of International Conferences on Environmetrics, which was

held in Cairo in 1989, follow as a logical progression from the conferences organized at CCIW?

**El-Shaarawi:** Yes it did, but it had a much broader objective and was really setting the foundations for establishing The International Environmetrics Society (TIES). Thus the scope was broader than that of each of the earlier conferences, because we were thinking of including quantitative disciplines in addition to statistics, particularly applied mathematics and engineering.

**Esterby:** The keynote speakers at this conference set the multidisciplinary tone of the conference.

**El-Shaarawi:** There were two very accomplished keynote speakers, Professor John Stuart Hunter, well known to the audience of this journal, and Dr. Richard Vollenweider, senior scientist at the Canada Centre for Inland Waters and the 1986 recipient of the Tyler Prize for Environmental Achievement in recognition of his research on eutrophication. Stu spoke of the roots and scope of environmetrics, while Richard spoke of what scientists and decision-makers expect from environmetrics. There were other keynote speakers from statistics, applied mathematics, engineering and physics. Thus the conference had a truly multidisciplinary tone.

**Esterby:** This first conference was memorable in many ways. What were some of the most memorable things for you?

**El-Shaarawi:** The participants: their diversity representing a true multidisciplinary mosaic and large number of countries, their enthusiasm and how this was followed up in the succeeding years through their unselfish work for the establishment of TIES. The place and the social program, including the conference tour and postconference Nile cruise, were memorable. Also I think of the opportunity it provided for environmetricians to witness the great monuments of Egypt, how Egypt's land has been affected by man since ancient time and the fragility of the environment.

But perhaps most importantly, in terms of starting a new society, the conference established a forum that provided support for individuals in various countries who were starting to work on environmental problems but had few colleagues in their own country doing similar work.

**Esterby:** The Society and the *Environmetrics* journal had their beginnings in this international Cairo conference.

**El-Shaarawi:** Yes, this is when the participants agreed to the establishment of the society and the journal. Ian MacNeill and I were delegated the task of starting the process, that is, of establishing the Society, and I was selected President and Ian Vice-President.

FIG. 2. *The 1989 conference in Cairo, in a meeting room in the Ramses Hilton where the conference was held, with (left to right) Ian MacNeill, Stu Hunter and Abdel.*

We were supported by a core group of colleagues, including you. Working with the three of us to put procedures in place were Mac Berthouex, Stu Hunter and Wesley Pipes from the USA, Bill Rieger from Australia and Reinhard Viertl from Austria. Wes and Mac, who are engineers, and Bill, who is a geographer, helped us set the scope of TIES in broad terms.

**Esterby:** How was it that you and Ian MacNeill decided to publish the journal out of the University of Western Ontario?

**El-Shaarawi:** It was my earlier experience publishing the conference proceedings with Elsevier and Kluwer, who were interested in publishing proceedings but not keen on publishing a journal. So we decided not to pursue this approach again. Instead Ian and I decided to establish a small company. We called it Envi-

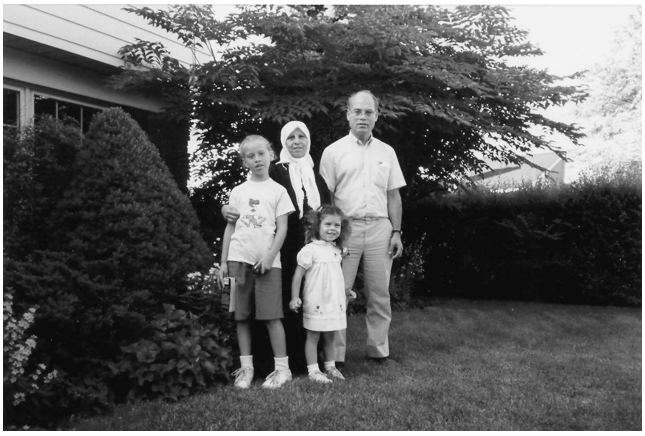

FIG. 3. *Abdel and his mother, Wahiba Shoukry, visiting from Egypt in front of the family home in Burlington, Ontario about 1990, with the daughters of Abdel and Sylvia, Nadia (left) and Sarah (front).*

ronmetrics Press, and its role was for the publication of *Environmetrics* and the first conference in Cairo. To publish the journal the company hired facilities at the University of Western Ontario for word processing and typesetting. Publication by Environmetrics Press lasted only for Volume 1 since John Wiley & Sons became interested in publishing *Environmetrics*. This seemed to be a means of ensuring the success of the journal, and Environmetrics Press was dissolved. Publication from Volume 2 onward has been by Wiley.

## CONFERENCES AND BUILDING *ENVIRONMETRICS*

**Esterby:** There were many successful conferences after this first one. The next three were in Italy in 1990, the United States in 1991 and in Finland 1992. The Society was incorporated in 1993. Would you tell us about these conferences and some of the people involved?

**El-Shaarawi:** Richard Vollenweider proposed Como, Italy, for the second conference in 1990, and Ian McNeill and I were cochairs. The suggestion of this location was welcomed because it is a beautiful place in Europe and it was on Lake Como, almost forty years earlier (Bellagio, Italy in 1953), that the International Biometric Society held its third international conference. It was also memorable as the first meeting of the board and here we began the discussions with the conference participants on the governing principles for the Society. The 1991 conference was held in Espoo, Finland, and organized by Jari Walden from the Finnish Meteorological Institute and myself. Due to Jari's efforts, funds were obtained to support participants from Eastern European and developing countries.

Mac Berthouex organized the 1992 conference in USA. Bill Hunt's keynote address gave accounts and showed spectacular pictures of the devastated Kuwaiti oil wells during the 1991 Gulf War. I also recall the presentation by George Box and his participation in the panel discussion where he emphasized that meaningful statistical development arises from dealing with scientific problems and through the interaction with subject-matter scientists.

**Esterby:** Could you give us a few highlights of the later conferences?

**El-Shaarawi:** We held conferences on each continent and the conferences had participants from developed, developing and underdeveloped countries. This in turn increased the visibility of the work that was being done in the environmental areas. The 1994 Burlington conference was remarkable in terms of participation (the largest) and topics covered. Sir David Cox, David Brillinger, C. R. Rao, Bill Fyfe, Jef Teugels and Frank Hampel were among the participants, as were many well-known scientists who were not statisticians. This was followed by conferences in Malaysia, Brazil, Austria, Australia, Greece, the United Kingdom, the United States and Italy, in that order, between 1995 and 2002.

Of course the opportunity to meet and work with people from all over the world was very exciting. Another aspect is the continued associations that have evolved, such as the involvement in the conferences of a group of applied mathematicians, started by Paul Sullivan and Philip Chatwin at the Cairo meeting, and the collaboration with other societies, such as that with the Modelling and Simulation Society of Australia that began as a result of Tony Jakeman attending the Cairo conference. TIES has also been collaborating with other societies including the Section on Statistics and the Environment of the American Statistical Association and the Bernoulli Society. We worked together with many other individuals on TIES initiatives and I particularly want to mention the unselfish work of Eric Smith.

**Esterby:** In 2002, Wiley published the *Encyclopedia of Environmetrics* with you and Walter Piegorsch as editors. This was a large undertaking and it would seem to be an indication that the subject had reached a certain stage of maturity.

**El-Shaarawi:** The publication of this major reference work, which includes more than 500 detailed

FIG. 4. *During the midconference tour at TIES 2002 in Genoa, Italy. Mohammed El-Saidi (left), Abdel and Eric Smith. Behind them, also enjoying the cruise, are other conference attendees, including Ulla Holst.*

articles, is a landmark for environmetrics. It really defines the subject and indicates its future directions (El-Shaarawi and Hunter, 2002). As can be seen, there is no shortage of real problems for scientists to work on, where their investigations have direct impact on improving the quality of life for the current and future generations.

**Esterby:** Let us return to the topic of research. You have had associations with a number of universities and also have had a number of research associates work with you at the National Water Research Institute (NWRI).

**El-Shaarawi:** My view is that statistical research will have more beneficial impact within and outside the field of statistics when it deals with real problems. My position at NWRI and my university associations have given me the opportunity to horizontally collaborate with nonstatisticians and to provide guidance to younger statisticians and students who were interested in working on environmental problems. My graduate and postgraduate students and research assistants developed suitable statistical methods to deal with particular environmental problems. For example, the doctoral thesis of Armand Maul focused on spatial and temporal variations of microbiological quality of drinking water, while that of Tarit Saha dealt with contaminants in the Niagara River and David Dolan's work was on contaminated sediments in the Great Lakes. My postdoctorate fellows and research assistants worked on water quality and acid rain problems. A. Naderi, A. Al-Ibrahim, H. Al-Nachawati, S. Niculescu (El-Shaarawi and Niculescu, 1993), C. Pause and K. Arnbjerg-Nielsen are some of the individuals who have spent time at NWRI. My collaborators include Eivind Damsleth (Damsleth and El-Shaarawi, 1989), Roman Viveros, Jef Teugels (Carbonez, El-Shaarawi and Teugels, 1999), Lucio Barabesi (Barabesi and El-Shaarawi, 2001) and A. Al-Zaid. Other areas became of interest because of problems to be solved (Esterby and El-Shaarawi, 1981).

**Esterby:** You still have a fascination with the topics you were introduced to as a student in Cairo. Tell us more.

**El-Shaarawi:** The intersection of statistics and mathematics fascinates me. In particular, I am very much interested in matrices, their applications to statistics and how some results of matrix theory can be easily obtained using statistical ideas, such as obtaining the inverses of special matrices or constructing design as well as stochastic matrices. Also the computational aspects of statistics are interesting.

**Esterby:** Are there some new or current research projects that you would like to mention?

**El-Shaarawi:** Currently, at the invitation of Professor Vincenzo Doví, I am spending a sabbatical year in the Department of Chemical Engineering at University of Genoa, where my Italian colleagues and I are studying the transport and effects of pollution on the near-shore zone of the marine environment and particularly on Italian ports. We are assessing the ability of engineering-based models to explain observed measurements and thus their use as a management tool for pollution control and for setting regulations.

**Esterby:** To close this interview let us look ahead. What are your thoughts about the future of statistics?

**El-Shaarawi:** I am optimistic about the future of our field. It has been around for a reasonably long time and has been quite successful expanding in terms of its methods and their range of application. Without any doubt, I would say that statistics is the broadest field of science in terms of the use of its methods. The same formula for advancement as used by the great statisticians in the past, if used by the current generation, will guarantee a bright future for the field. This formula requires that statistical methods should be developed to address real problems in science and technology, and statisticians should be taught how to effectively communicate with others.

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