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Summary Report of the
WORKSHOP ON THE CONTRIBUTION OF
SCIENCE AND TECHNOLOGY TO DEVELOPMENT

Santiago, Chile
January 11 - 15, 1971

AID/csd-2584

Co-Sponsored with the
National Commission for Scientific and Technological Research of Chile
(Comisión Nacional de Investigación Científica y Tecnológica)
and the
Office of the Foreign Secretary
NATIONAL ACADEMY OF SCIENCES
Washington, D.C.

This summary report, compiled from reports of the five joint working groups and staff notes, records the issues discussed and the conclusions reached at the Chile - U.S. Workshop on the Contribution of Science and Technology to Development held in Santiago, January 11 - 15, 1971. The workshop was sponsored by the Board on Science and Technology for International Development, Office of the Foreign Secretary, National Academy of Sciences, and the National Commission for Scientific and Technological Research (CONICYT) in Chile with the support of the U.S. Agency for International Development. This report is part of a continuing study of science organization and development in a number of countries currently being conducted by the National Academy of Sciences - National Research Council under contract AID/csd-2584; It will be presented to the Board on Science and Technology for International Development and will be made available to interested institutions in Chile. A record of the full proceedings in Spanish is to be issued by the CONICYT.

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I

INTRODUCTION

The National Academy of Sciences (NAS) became actively concerned with the advancement of Chilean science during the early years of the Alliance for Progress. In October, 1964, the Academy--in cooperation with the Chilean Embassy, the Smithsonian Institution, the Organization of American States, and the National Geographic Society--organized a week-long series of symposia on "Science and Development in Chile." More recently, collaboration between the Academy and the scientific community of Chile was resumed in early 1970, as a result of discussions between the U.S. AID Mission in Chile and the Chilean National Commission for Scientific and Technological Research (CONICYT). At the suggestion of U.S. AID/Santiago, the idea of a cooperative program between the Academy and CONICYT was discussed in June, 1970, in a visit to Washington by Dr. Jaime Lavados, then Executive Secretary of CONICYT. Shortly thereafter, Dr. Harrison Brown, Foreign Secretary of the NAS, met in Chile with senior officers of CONICYT to discuss the possibility of convening a joint workshop on the role of science and technology in Chilean national development. Agreement was reached for a workshop to be held in Santiago, January 11 - 15, 1971.

Workshop Objectives

In convening the workshop, NAS and CONICYT hoped that a broad continuing program of bilateral scientific cooperation would emerge that would lead to the following:

1. A systematic analysis of the role of science and technology in the national development of Chile. The workshop would be a first step toward this goal.

2. A strengthening of ties between the Chilean and U.S. scientific and academic communities at all levels;

3. A strengthening of Chilean scientific and technical institutions to increase their capabilities to participate in national development planning; and

4. Effective collaboration between the scientific communities of Chile and the United States in analyzing research needs and opportunities in terms of Chile's resource base and its national development goals. Practical mechanisms were to be identified through which the research needs could be met effectively.

The agenda agreed upon for discussing these objectives included the following topics:

1. Science Policy. A review of the methods for determining priorities among numerous needs in science and technology and a discussion of the kinds of data needed and the methods of obtaining it;

2. Marine Sciences. An examination of research needs in relation to both physical and biological aspects of utilizing ocean resources in the economic development of Chile;

3. Nutrition and Food Technology. A consideration of national nutritional requirements and specific ways to fulfill them, with emphasis upon increased food production and improved marketing;

4. Mathematics and Computer Sciences. An inventory of manpower needs in pure and applied mathematics and in the computer sciences; and

5. Copper Technology. A review of the copper industry's needs and priorities for research and development.

In November, 1970, after the change of government in Chile, Dr. Jaime Lavados visited the NAS and reaffirmed the desire of both CONICYT and the Government of Chile to proceed with the workshop. To provide a basis for the subsequent discussions, pre-workshop meetings and site visits were planned for the NAS panel and Chilean scientists and engineers. The NAS panel also met in Washington, December 29, 1970, for orientation and discussion of the agenda.

The workshop brought together a NAS panel of 11 members, 36 Chilean panelists, and about 60 observers for a week of deliberations in both plenary and working-group sessions. The pages that follow provide but a summary account of their efforts.

II

HIGHLIGHTS AND COMMENTS

The joint Workshop on the Contribution of Science and Technology to Development took place at a critical time in Chile's history. Its new government and the interested public were critically examining and evaluating existing institutions and policies, including scientific institutions and policies. Problems in nutrition, marine sciences, and copper technology were surging to the forefront of national attention. The use of new technologies in Chile's development, including computer technology, were under scrutiny. Implementing the new priorities, as well as maintaining the traditional areas of science and engineering, required a coherent science policy.

Within this state of ferment, Chilean scientists, engineers, and policy makers representing diverse organizations and points of view and high-caliber, disinterested U.S. scientists worked together to clarify the issues and constraints and to recommend courses of action.

The Workshop

On both sides, the workshop was well planned: agenda topics were carefully defined, and the panel members for each working group chosen appropriately. Both the Chilean and U.S. participants held preliminary briefing sessions. During the week before the workshop, each working group visited selected Chilean universities, government agencies, and industrial facilities.

When the workshop began, President Allende had just taken office, with resulting confusion and uncertainty. Nevertheless, the CONICYT staff, despite the uncertainty of their tenure, worked efficiently and with great dedication. Furthermore, the workshop was unsure of financial support, because the Chilean fiscal year coincides with the calendar year and annual budgets had not been specified. CONICYT had to work out special arrangements with the government shortly before the workshop began.

The opening plenary session was held at the National Library. Immediately thereafter, the five working groups dispersed to meet in three hotel suites, the CONICYT main headquarters, and the offices of another organization. Simultaneous translation was provided for all sessions, both plenary and working group.

In each session Chilean organizations were well represented. Discussions were free, tackling sensitive problems and issues in the various Chilean agencies and universities in a very productive way. For 3 days the working groups labored long hours on policy questions. Reports were typed and mimeographed late Thursday night by the dedicated CONICYT staff in time for distribution at the beginning of the final plenary session on Friday morning.

An expected meeting on Tuesday afternoon with President Allende at the Fisheries Research Institute did not take place as planned. President Allende visited the Institute and referred to the Academy study in progress, but did not speak directly to any member of the NAS panel.

The final plenary session was open to the public, with a large attendance that included representatives from the United Nations, the Ford Foundation, and AID.

AID Involvement. The AID Mission Director's support was the decisive factor in the decision to carry out the workshop. While trying to keep the AID profile low, the Mission offered help with transportation and administrative support. A reception was held for the joint panel early in the week at the U.S. Ambassador's residence. This social occasion undoubtedly promoted a more relaxed relationship between the Chilean and U.S. participants.

Follow-up

Immediately after the workshop several high-level CONICYT officials resigned, a prelude to a larger reorganization that took place over the next few months. Communications between NAS and CONICYT were sparse until the visit of Hellmuth Sievers with Harrison Brown in Washington. Mr. Sievers, a Chilean workshop participant and a scientist at the Naval Hydrographic Institute, reported that a CONICYT planning group in marine sciences had met in early May, 1971, to discuss and debate the workshop's Marine Sciences Report. In the end, the planning group accepted the entire report and formed commissions in each of the areas defined by the workshop. Mr. Sievers was particularly interested in NAS advisory support in one or more specific areas, such as air-sea interaction as it related to meteorology, the upwelling phenomenon, and marine pollution.

Mr. Sievers's visit and his personal initiatives made it possible for Dr. James Zavistoski to stop over in Santiago in July, 1971. He was received very cordially by the CONICYT President, Dr. Victor Barberis, who stated his wish to continue the CONICYT relationship with NAS but asked that the decision on specific activities be deferred until after the

convening of a National Science Congress, then scheduled for September, but subsequently postponed until July, 1972. Dr. Zavistoski found that most of the staff officers with responsibilities for some part of the workshop were still at work within CONICYT, but in some cases their responsibilities had changed.

Discussions with these staff officers gave some indication of the workshop's most immediate impact. The role of the Marine Sciences Report was considerable. Although mathematics was not among CONICYT's highest priorities, they had acted on three of the workshop recommendations. So much national attention had been given to nutrition and food technology that it was difficult to determine the effect of the workshop. A national office of nutrition has been set up, as had been recommended, but its responsibilities are not clear. The Copper Technology Report stressed the urgent need for training and resulted in the organization of several short courses in Chile by U.S. scientists.

III
SUMMARY OF RECOMMENDATIONS

Science Policy

The joint working group on science policy agreed on the following observations and recommendations:

1. The development of a national scientific and technological capacity is indispensable to the progress of the country.
2. To benefit the development of the nation, the public should become aware of the important role science and technology play in improving living conditions.
3. In planning national scientific and technological programs, support from the scientific community is of fundamental importance, and the participation of both social and natural scientists is highly desirable.
4. Many urgent socioeconomic problems might be solved with significant contributions from science and technology. The scientific community ought to identify these key problems and then focus their efforts and resources on them.
5. Although significant financial assistance has been provided for the growth of science and technology in recent years, a new increment of funds is required for research (basic and applied) and development to make possible effective scientific participation in the national development effort.
6. Special consideration should be given to non-degree programs for training technicians in universities and institutes. The emphasis should

be on the high priority fields, discussed in point 4.

7. To be effective, national programs of research and development should be concentrated in institutions considered to be centers of excellence. In each institution, responsibility for the operation and fiscal management of each program should be delegated to specific persons.

8. To determine the amount of resources that the country invests, and should invest, in science and technology, the budgets of Chilean institutions should contain a separate line item for research.

9. CONICYT and NAS should continue the exchange of ideas on science policy at a mutually agreeable time and place.

Marine Sciences

The joint working group on marine sciences discussed a wide range of topics with the objective of defining the steps that should be taken, in the course of economic development, to exploit Chile's marine resources rationally.

1. Upwelling and Fishing. The high biological productivity of the ocean off the northern and central coasts of Chile is due to the upwelling phenomenon; island fishing, which predominates there, is tied to the time and space fluctuations of the upwelling. Because the complex relationships between the upwelling and fishing are not well understood, both the biological and physical aspects need to be studied extensively and systematically in order to use and maintain the fishing resources that are dependent upon the upwelling phenomenon.

2. Demersal Resources of the Chilean Central Zone. The Chilean central zone contains abundant demersal resources, some of which are ex-

ploited, but with insufficient fishing technology and inadequate biological and oceanographic knowledge. Additional research is urgently needed for more rational use of these resources. Although government agencies are responsible for, and should play a major role in, the research, the participation of the academic community is indispensable.

3. Aquiculture. Aquiculture is important to Chile for national consumption and for export. Again, specific studies need to be made to find ways to increase the production and quality of certain marine species, for example, bottom-dwelling fish, through fish-farming and fish genetics. Along the southern coast, cultivation and control of exploitation is urgently needed because the natural banks are nearly exhausted. Aquicultural practices could be extended to a number of commercial species along the central and north coasts. To exploit the oyster and mussel wisely, studies are needed to elucidate the biological and nonbiological parameters of their environment. Undisturbed reserves should be studied to gain information about the effects of human intervention in exploited regions.

4. Fishery Resources in Southern Regions. To maintain the fishing of whales, new catch controls must be instituted to restore the natural populations. It is also necessary to institute a series of studies of the fjords, the canals, the Patagonian continental shelf, and the Antarctic to extend the possibilities for exploitation. Of particular interest is a study of methods for catching, processing, and marketing of krill. Such research projects require ships and land-based logistics support that do not now exist. The possibility of establishing a research station in the Punta Arenas region also needs to be investigated.

5. Marine Pollution. The scientific, economic, and social aspects of ocean pollution need to be considered extensively. Studies should emphasize the development of indices to measure the degree of pollution; creation of a public awareness of conservation; and legislation to control industrial waste disposal and to introduce a permanent public register of environmental contaminants. It is recommended that a special seminar be held to consider the consequences of pollution and means to abate it.

6. Ocean Circulation and Interaction between the Ocean and the Atmosphere. Research in this area requires the combined efforts of physical, chemical, and meteorological oceanographers. Information is badly needed, and research is recommended, on the ocean currents and hydrospheric-atmospheric interactions of the Pacific, to make it possible to foresee their effects on national development--for example, on port construction and coastal erosion. Implementing these programs is seriously hampered by a lack of properly trained personnel at all levels and a shortage of essential equipment, especially modern research vessels.

7. Marine Geology and Exploitation of Nonrenewable Resources. The principal nonrenewable marine resources that may exist off Chile and that would be worth exploiting are (a) heavy metals on beaches and in shallow waters, (b) nodules of phosphorite on the continental shelf in upwelling zones, (c) petroleum and natural gas on the continental shelf, and (d) nodules of manganese in the abyssal plain. None of these resources is currently under exploitation. To identify and evaluate them, it is necessary to develop an overall marine-geology program within the national ocean-sciences program. International collaboration could be of great help in developing such a marine geoscience program.

8. National Oceanographic Sample and Data Centers. A National Center for collecting, processing, and storing data is of great importance, and Chile should serve as a regional collection-and-sorting center for the southwest Pacific area. The experience of the Smithsonian Oceanographic Sorting Center in Washington could well be utilized in this effort. The Chilean National Oceanographic Research Center needs additional support to accelerate its development so that it may store and classify biological and geological samples, as well as collect physical and chemical samples from the ocean.

9. Human Resources for the Marine Sciences. The joint working group agreed that the principal factor limiting development of the marine sciences in Chile is a lack of human resources. To encourage the training of scientists and other personnel, as well as to coordinate the currently fragmented teaching and research efforts among the various institutions in Chile, a special study should be undertaken in which the experience of other countries in developing human resources for the marine sciences should be considered.

10. Planning and Research-Control Requirements. In Chile, the coordination of institutions and the evaluation of research results in the marine sciences are just beginning and must be developed substantially. The joint working group recommended that

- a. The Marine Sciences Development Group in CONICYT participate fully in formulating national policy for this area;
- b. Coordination mechanisms be created among the various academic and nonacademic institutions engaged in the marine sciences in Chile;
- c. An independent national association of scientists engaged in the marine sciences be established;

d. A balanced program of basic and applied research be maintained in Chile; and

e. Financial assistance for the publication of high-quality research be granted.

Nutrition and Food Technology

1. Nutrition. After a full discussion of available evidence on the status of nutrition in Chile, the joint working group felt that the primary problem is one of undernourishment, although there are other problems that ought also to be analyzed and solved. The group recommended that

a. A national nutrition policy be established and an autonomous agency be created to carry out activities in the nutrition sciences;

b. Standards on nutritive quality and toxicological safety be issued for compliance by all government agencies, quasi-governmental organizations, and private groups engaged in food production and research;

c. Information be made available on the quality of food products on the market;

d. A new food health code be studied and proposed;

e. A national nutrition-education policy be adopted;

f. The addition of new nutritive elements in the processing of food for human consumption be examined;

g. Technological studies be undertaken of ways to improve production and processing of foods of national importance.

h. A study be made of the effects of inadequate food on Chilean development;

i. The training of professional persons in the nutritional sciences be stimulated through scholarships, courses, and other programs;

j. The results of past nutrition programs carried out in Chile be evaluated; and

k. Research in various aspects of basic or applied nutrition be planned and sponsored, preferably using human and material resources existing at universities or other technical and scientific organizations.

2. Food Technology. Food technology, as defined by the joint working group applies to the conversion of raw materials of biological or synthetic origin into food through the application of basic science. Because it represents 26 percent of the industrial GNP, the food sector is fundamental for Chilean development. Currently, Chile imports \$150 million in food products. Recognizing the obvious importance of the food sector, the group made the following observations and recommendations:

a. It is essential to make a diagnosis of the food industry in terms of technical, public health, and nutrition problems, as well as economic factors. It is also necessary to evaluate personnel training, activities, and research in Chile in food technology and nutrition.

b. It is important to establish a limited number of centers of excellence in food science and technology. The centers' principal task should be to facilitate the transfer and adaptation of the technology of the developed countries. The centers should be multidisciplinary in their outlook, serve as a link between basic research and industrial application, and cooperate closely with existing nutrition, agriculture, and marine-sciences agencies.

c. To make better use of the existing research capacity, adequate funds are essential.

d. Considering the serious protein shortage in the diet of many

Chileans, a short-term research project on protein-enriched foods should be undertaken, to include pilot-plant operation, technical economic studies, food habits, and marketing.

e. It is necessary to establish a central standardization and health-quality control agency for consumer protection.

f. Chile must participate actively in the development of KODEX ALIMENTARIUS (food code). This requires full cooperation between research centers and industry.

g. The development plans for the food industry of Chile must contemplate a radical reorganization for the purpose of improving technical processes, health conditions, and quality.

h. One of the national development goals of Chile must emphasize the export of food products and food technology.

i. To provide the necessary manpower resources for food science and technology, a study of professional requirements on all levels is needed.

j. Better coordination of human and material resources in universities and research institutes is required in the food science-and-technology sector.

k. Planning in food science and technology, as well as nutrition, must take full cognizance of the work being done in agriculture and fisheries.

l. To support the implementation of these recommendations, continued cooperation between CONICYT and NAS is desired.

Mathematics, Statistics, and Computer Sciences

1. Mathematics and Statistics. Almost all Chilean universities have programs leading to a basic degree in mathematics, more or less equivalent

to the Master of Science level in the United States. Although without a long tradition, the programs are well designed, and the few mathematicians or statisticians who are engaged in research are widely scattered throughout the universities. To strengthen training in mathematics and statistics, the joint working group recommended that

a. A program of visitor-exchange be instituted to bring foreign mathematicians and statisticians to Chilean universities for teaching and research for periods of from one semester to two years;

b. A very complete mathematics research library with a broad collection of books and journals be formed;

c. Fellowships for study abroad be made more readily available to the most promising candidates who have completed their basic mathematics or statistics training in Chile, since it is considered premature to begin a doctorate program within the country;

d. National scholarships for studies in Chile be strengthened; and

e. Efforts be made to educate the industrial and government sectors in the importance of, and use of, statistics.

2. Computer Sciences. Because of the recent introduction into Chile of the computer, there is a great shortage of well-trained personnel there. Furthermore, the scarcity of computer facilities and their high cost limits opportunities for training specialists in this field. Therefore, the joint working group on computer sciences recommended that

a. Incentives be provided to stimulate training of computer scientists, engineers, technicians, and other specialists at all levels;

b. Basic computer training should be offered in all university degree programs;

c. Research in computer science be promoted as the most effective means to provide needed back-up for high-level instruction;

d. The establishment at the universities of adequate computer centers be encouraged;

e. Coordination among the universities be strengthened through the existing University Computer Association;

f. An advanced scholarship plan be instituted for Chilean professors to study abroad; and

g. Working meetings be continued for discussion and cooperation in such areas as (1) administration of computer centers, (2) computer-teaching problems, (3) shared-time techniques, (4) programmed teaching with computers, (5) information systems for industry, and (6) computer science research.

Copper Technology

The nationalization of the copper industry affords Chile an excellent opportunity for expanding copper science and technology at all levels, provided that certain limiting factors can be overcome--particularly the lack of trained personnel.

The integration of education and the existence of university research institutes and government laboratories offer an opportunity to coordinate research and development for maximum results and the best utilization of resources.

The successful conduct of research hinges on an adequate supply of trained engineers and technicians. Therefore, questions of education in mining, metallurgy, and supporting fields must be given high priority.

During the next few years, assistance from other countries will be especially significant in strengthening university teaching, instituting basic research programs, providing mechanisms for exchange of scientific data, and developing new educational programs. The joint working group recommended that CONICYT and NAS seek means to collaborate in copper technology, particularly in facilitating the exchange of professors with broad research experience and the development of university research programs. As a first step, a copper-technology panel should be created to select specific projects that most urgently warrant attention. Among these projects might be

1. Finding support for seminars in specific areas identified by the Chileans to which would be invited U.S. and other representatives of known reputation in copper technology;
2. Creating programs of continuing education for Chilean scientists, engineers, and technicians in the copper industry;
3. Immediate development of graduate education in metallurgical engineering and other fields essential for research and development in copper; and
4. Assistance with library development and technical information services.

IV

AGENDA

Briefing Meeting, NAS, Washington, D.C., December 29, 1970

- MORNING "Workshop Activities of the National Academy of Sciences,"
Dr. Harrison Brown, Foreign Secretary, NAS.
- "The Role of Science and Technology in AID Programs,"
Mr. Glenn Schweitzer, Director, Office of Science and
Technology, Technical Assistance Bureau, AID.
- "The Role of Science and Technology in OAS Programs,"
Dr. Jesse D. Perkinson, Director, Department of
Scientific and Technological Affairs, PAU.
- Remarks by Sra. Estele de Rojo, Cultural Attaché,
Embassy of Chile.
- AFTERNOON "Chile and the United States," Mr. Lewis Girdler, Chile
Desk Officer, Joint State-AID Bureau for Inter-American
Affairs, Department of State.
- Executive Session.

Workshop, January 11 - 15, 1971

- January 6 - 10 The NAS panel members arrive during the week before the
workshop to make site visits pertinent to their respon-
sibilities, accompanied by Chilean counterparts assigned
by CONICYT.
- January 11 Opening Plenary Session with presentations by Drs.
Enrique D'Etigny Lyon, Harrison Brown, and Eduardo
Bobadilla. First sessions of the five working groups
held during the afternoon.
- January 12 - 13 Sessions of the five working groups.
- January 14 Sessions of the five working groups. Drafting of reports.
- January 15 Closing Plenary Session. Distribution of working group
reports and presentation for consideration and agreement.

V

LIST OF CONICYT REPORTS AND DISCUSSION PAPERS

Science Policy

"Criteria for the Formulation of a Science Policy,"
Marcelo Robert Briere.

"Planning in the Social Sciences for Socioeconomic Development,"
Carmen Reyes Vergara.

Marine Sciences

"Oceanology in Chile and its Development Alternatives,"
Fernando Robles.

Nutrition and Food Sciences

"Basis for the Elaboration of a Program of Scientific and Technological
Development in Nutrition and Food Production and Processing,"
CONICYT Staff Report.

Mathematics and Computer Sciences

"A Project for the Development of Mathematics in Chile,"
CONICYT Staff Report.

"Statistics in Chile," CONICYT Staff Report.

"Current Availability of Computers in Chile,"
CONICYT Staff Report.

Copper Technology

"Objectives of the Discussion on Copper with the National Academy of
Sciences," CONICYT Staff Report.

VI

WORKSHOP PARTICIPANTS AND OBSERVERS

CONICYT Panel

Science Policy

Enrique D'Etigny Lyon, Chairman
Vice President
National Commission for Scientific
and Technological Research (CONICYT)
Dean, Faculty of Physical and
Mathematical Sciences
University of Chile
Santiago

Eduardo Bobadilla
Acting Executive Secretary
National Commission for Scientific and
Technological Research (CONICYT)
Santiago

Joaquín Cordua Sommer
School of Engineering
University of Chile
Santiago

Juan de Dos Vial Correa
Faculty of Chemistry and Pharmacy
University of Chile
Santiago

Carlos Fortín Cabezas
School of Political and
Administrative Sciences
University of Chile
Santiago

Bruno Gunther Schaffeld
Institute of Physiology
University of Chile
Santiago

Joaquín Luco Valenzuela
Professor of Neurophysiology
Faculty of Medicine
University of Chile
Santiago

Marcelo Robert Priere
Head, Department of Studies
National Commission for Scientific
and Technological Research (CONICYT)
Santiago

Oswaldo Sunkel Weil
Institute of International Studies
University of Chile
Santiago

Marine Sciences

Anelio Aguayo Lobo
Director
Department of Oceanology
Faculty of Valparaiso
University of Chile
Valparaiso

Nibaldo Bahamondes Navano
Director
Section of Hydrobiology
Natural History Museum
Santiago

Jose Castellá Arguelles
Department of Studies
National Commission for Scientific
and Technological Research (CONICYT)
Santiago

Lisandro Chuecas Muñoz
Central Institute of Biology
University of Concepción
Concepción

Hector Inostroza Villagra
Central Institute of Physics
University of Concepción
Concepción

Fernando Robles García
Fisheries Research Development
Institute (IFOP)
Santiago

Patricio Sanchez
Director, Zoology Laboratory
Institute of Biological Sciences
Catholic University of Chile
Santiago

Hellmuth Sievers Czischke
Director
Department of Oceanography
Naval Hydrographical Institute
Valparaiso

Jose Stuardo Barria
Central Institute of Biology
University of Concepción
Concepción

Nutrition and Food Sciences

Antonio Arteaga Llona
Department of Nutrition
Faculty of Medicine
Catholic University of Chile
Santiago

Fernando Monckeberg Barros
Laboratory of Pediatric Research
Faculty of Medicine
University of Chile
Santiago

Francisco Rudloff Manns
Department of Studies
National Commission for Scientific
and Technological Research (CONICYT)
Santiago

Max Rutman Soubotnik
Fisheries Research Development
Institute (IFOP)
CORFO
Santiago

Alex Trier Gabler
Institute of Technology of Chile
CORFO
Fisheries Research Development
Institute (IFOP)
Santiago

Mathematics and Computer Sciences

Rolando Chuaqui, Moderator
Dean of Mathematical Sciences,
Physics and Chemistry
Catholic University of Chile
Santiago

Julian Corcuera
Department of Studies
National Commission for Scientific
and Technological Research (CONICYT)
Santiago

Enrique Cansado
Director
Inter-American Center for the
Teaching of Statistics (CIENES)
Santiago

Rene Peralta
Director, Computation Center
Faculty of Science, Physics
and Mathematics
University of Chile
Santiago

Jorge Alvarez de Araya
Institute of Mathematics
Catholic University of Chile
Santiago

Copper Technology

Carlos Campino
Center for Promotion of
Uses of Copper
Santiago

Carlos Landolt
Center for Metallurgical
Mining Research
Santiago

Ivan Casanegra
Department of Studies
National Commission for Scientific
and Technological Research (CONICYT)
Santiago

Luis Soto-Krebs
Director, Engineering Department
Technological Institute (INTEC)
CORFO
Santiago

Carlos Diazuribe
Director, Department of Mines
and Acting Director, School
of Engineering
University of Chile
Santiago

Matias Turtletaub
Director
Mechanical Engineering Department
Technological Institute (INTEC)
CORFO
Santiago

Joselin González M.
Engineering Administrator
Ventanas Refinery (ENAMI)
Valparaiso

Carlos Ruiz Fuller
Institute of Geological Research
Santiago

Chilean Observers

Luis Aguirre Le Bert
Director, School of Geology
University of Chile
Santiago

Sergio Aviles
Marine Biologist
Department of Natural Resources
Fisheries Research Development
Institute (IFOP)
Santiago

Fernando Fuckle
Marine Biologist
Department of Oceanology
Faculty of Valparaiso
University of Chile
Valparaiso

Patricio Contreras
Marine Biologist
Department of Natural Resources
Fisheries Research Development
Institute (IFOP)
CORFO
Santiago

José González
Professor of Marine Biology
Department of Natural Resources
Fisheries Research Development
Institute (IFOP)
CORFO
Santiago

Marine Sciences

Edgar Kausel
Director, Department of Geophysics
and Geodetics
University of Chile
Santiago

Carlos Mordojovich K.
Head, Department of Geology
National Petroleum Company
Santiago

Pablo Ulriksen U.
Researcher
Department of Geophysics
and Geodetics
University of Chile
Santiago

Roberto Verdugo
Representative of the Department
of Industries of the Corporation
for the Promotion of Production
CORFO
Santiago

Carlos Viviani Richard
Researcher
Institute of Zoology
University of Valdivia
Valdivia

Mathematics

Cesar Abuabud
Director
Department of Mathematics
Faculty of Sciences
University of Chile
Santiago

Carlos Araujo
Inter-American Center for the
Teaching of Statistics (CIENES)
Santiago

Eugenio Balmaceda
Institute of Mathematics
Catholic University of Chile
Santiago

José Duran
Computer Center
University of Concepción
Concepción

Robert Frucht
Technical University of
Federico Santa Maria
Valparaiso

Ines Harding
The State Technical University
Santiago

Arnoldo de Hoyos
Faculty of Sciences
University of Chile
Santiago

Jaime Michelow
The State Technical University
Santiago

Carmen Reyes Vergara
Science Policy Division
Department of Studies
National Commission for Scientific
and Technological Research (CONICYT)
Santiago

Hugo Segovia
Department of Mathematics
Faculty of Physical and
Mathematical Science
University of Chile
Santiago

Gonzalo Vargas
National Computing Company (EMCO)
Santiago

Copper Technology

Federico Barros
El Teniente Copper Mine
Chile

Patricio Castro
Chemical Mining Society of Chile
Santiago

Fernando Concha
University of Concepción
Concepción

Ramon Eyzaquirre
Copper Corporation (CODELCO)
Santiago

Hans Feddersen
Chuquicamata Copper Mine
Chile

Carlos Gaymer
Corporation for the Stimulation
of Production (CORFO)
Santiago

J.H. Hamnett
Copper Manufacturers
Association (MADECO)

Klaus Hube
Catholic University of Chile
Santiago

Gunther Joseph
Center for Metals (IDIEM)
Santiago

Federico Lastra F.
National Mining Company (ENAMI)
Santiago

Francisco Negróni
Catholic University of Chile
Santiago

Ernesto Paz P.
Minister of Miners
Santiago

Joaquin Risopatron
Center for the Promotion of
Uses of Cobre
Santiago

Pablo Risopatron
Pacific Steel Company
Santiago

Alejandro Steiner
University of Chile
Santiago

Nicholas Tschischow
Chuquicamata Copper Mine
Chile

Manuel Turbino
Technical University of
Federico Santa Maria
Valparaiso

Victor Vergara S.
University of Concepción
Concepción

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Foreign Secretary
National Academy of Sciences
Washington, D.C.
(SCIENCE POLICY)

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Department of Electrical Engineering
Princeton University
Princeton, New Jersey
(MATHEMATICS AND COMPUTER SCIENCES)

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Department of Food & Resource Chemistry
University of Rhode Island
Kingston, Rhode Island
(NUTRITION AND FOOD SCIENCES)

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School of Medicine
Vanderbilt University
Nashville, Tennessee
(NUTRITION AND FOOD SCIENCES)

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Special Assistant to the
Deputy Assistant Director
National and International Programs
National Science Foundation
Washington, D.C.
(SCIENCE POLICY)

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Association of American Universities
Washington, D.C.
(SCIENCE POLICY)

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Department of Computer Science &
Stanford Linear Accelerator Center
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Stanford, California
(MATHEMATICS AND COMPUTER SCIENCES)

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Fisheries Research Institute
University of Washington
Seattle, Washington
(MARINE SCIENCES)

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Department of Metallurgical
Engineering
Colorado School of Mines
Golden, Colorado
(COPPER TECHNOLOGY)

Reinhardt Schuhmann, Jr.
School of Materials Science &
Metallurgical Engineering
Purdue University
(COPPER TECHNOLOGY)

Warren S. Wooster
Scripps Institution of Oceanography
University of California at La Jolla
San Diego Campus
California
(MARINE SCIENCES)

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United States Ambassador to Chile
Embassy of the U.S.A.
Santiago

Deane Hinton, Director
U.S. Agency for International
Development
Santiago

Jose Barzelatto
Organization of American States
Washington, D.C.

Peter Bell
Representative
Ford Foundation
Santiago

Norman Collins
Program Assistant
Ford Foundation
Santiago

Andre Colpitts
Science Officer, USAID Mission
c/o Embassy of the U.S.A.
Santiago

Charles Cooper
United Nations Development Programme
Santiago

Staff

Jean García de Huidobro
National Commission for Scientific
and Technological Research (CONICYT)
Santiago

Gerado Gargiulo
Special Consultant to CONICYT
Organization of American States
Santiago

Burton W. Jones
Department of Mathematics
University of Colorado
Boulder, Colorado

Elon Lages Lima
Institute of Pure and
Applied Mathematics
Federal University of Rio de Janeiro
Brazil

Howard Lusk
Higher Education Advisor
USAID Mission
Santiago

John Robertson
United Nations Development Programme
Santiago

Andre Simonpietri,
Scientific Attache
Embassy of the U.S.A.
Buenos Aires

James G. Zavistoski
National Academy of Sciences
Washington, D.C.