Recommendations for Development of Arid Lands

International Arid Lands Conference

The International Arid Lands Meetings opened at the University of New Mexico in Albuquerque the evening of 26 April with a symposium composed of three public evening lectures and four technical sessions. The technical sessions, in harmony with the theme of the meetings—"What is the future of arid lands?"—explored possible lines of future research and development in the subject-areas of (i) variability and predictability of water supply in arid regions; (ii) better use of present resources; (iii) prospects for additional water sources; and (iv) better adaptation of plants and animals to arid conditions. These sessions featured papers by experts from all parts of the world and open discussion from the floor. An additional day was devoted to informal discussion by 12 groups, each of which focused on a specific problem of arid-land development. Material from the symposium papers and from the discussions served as a pool of ideas from which problems to be considered at a conference held 2–4 May were selected. The conference took place at New Mexico Institute of Mining and Technology in Socorro.

A 2-day field trip through southwestern New Mexico gave the conference participants an opportunity to get better acquainted, to discuss problems and exchange experiences in an informal way, and to observe an arid region of the United States and the measures used to increase its productivity.

The Socorro conference, composed of 71 participants from 18 countries, had as its purpose the exchange of views and the formulation of recomendations for future lines of research and development for the arid zones of the world.

The first day was devoted to a review and evaluation of the problems and development of the Rio Grande Valley as a typical arid area and of problems and procedures involved in planning and conducting integrated surveys of semiarid and arid zones.

On the second day, the conference separated into three working groups with the following general assignments: new approaches needed in meteorology and applied climatology; the concept of the water budget and its areal application; and closing the gap between scientific knowledge and its application to arid-lands development. Each group formulated a series of recommendations to be considered by the conference as a whole on the final day. The conference considered each recommendation, combined, modified, and clarified some, and approved those that follow.

Anthropology and Archeology

1) A bibliography of our present knowledge of biological adaptations of man and of the cultural patterns in arid climates, past and present, is needed to promote specific research in these areas. Such research would contribute to the betterment of living conditions and to planning for greater safe use of arid areas.

2) Further research, in addition to the diffusion of information, is needed concerning the history of land use, especially agriculture, in arid and semiarid regions. Information in this field has practical applications in land-use planning, and our present knowledge is very sketchy. The UNESCO Advisory Committee on Arid Zone Research is urged to consider means of furthering research on this subject and to consider the publication of a volume dealing with agriculture of the past in the arid and semiarid lands of the world.

3) Exploration is needed of possible new patterns of resource use and practice with local participation in the studies to insure the public understanding so necessary for achieving any change, even on a gradual basis. There is a tendency to encourage the maintenance of existing patterns, even when it is realized that existing patterns have been inherited from conditions quite dissimilar to those of the present. Land-use histories may be valuable in dramatizing climatic hazards; there is need for long-term improvement in management; and even statistical data on climatic change can be effectively and convincingly presented if they are properly organized.

Meteorology and Climatology

4) The conference notes with satisfaction the recent action of the UNESCO Advisory Committee on Arid Zone Research in planning to devote the next arid-lands symposium to climatological problems of arid lands and urges sponsorship of continued research of arid-land climatology by the committee.

5) It is recommended that the program of the International Geophysical Year, which previously emphasized polar observations, be extended in 1957–58 to include, to the maximum extent possible, the arid belt of the world, and, in addition, that arid-zone countries involved be asked to participate in this program. Although the original plan of the International Geophysical Year has been expanded, the vast arid and semiarid areas of Africa, Asia, Australia, North America, and South America—30°N to 30°S principally—are still poorly represented in the list of longitudinal and latitudinal sections fixed for intensive observations.

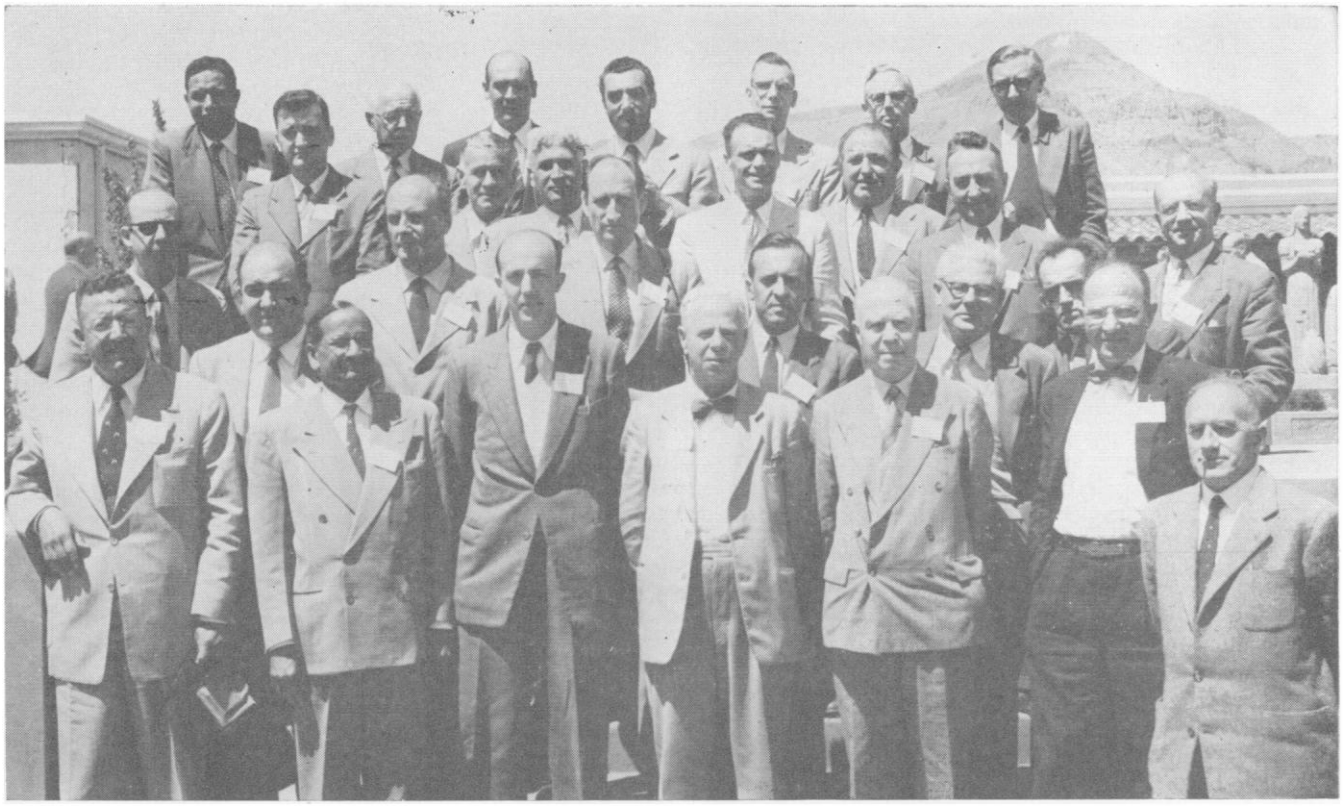
The observations of solar radiation and of other meteorological elements on the surface and in the upper atmosphere in the arid countries, and specifically along a parallel of latitude through as many as possible of the world's deserts, should be useful in the solution of arid- and semiarid-zone problems. Intensification of observations at the national level will enable arid-zone countries to benefit even more from the international aspects of the International Geophysical Year.

6) More effective climatic studies require an increase in density and improvement in representativeness of meteorological stations (both at sea level and at higher elevations) for surface and upper-air observations in all arid areas.

7) Careful attention should be paid to current research studies concerning relationships of solar emanations and terrestrial weather patterns, with particular attention to the effects that may bear on arid-land problems.

8) Synoptic and dynamic climatological studies, in different arid and semiarid regions, are essential. Emphasis should be placed on interrelationships between the general circulation of the atmosphere at upper levels as well as at the surface and the precipitation in different parts of the areas and at different times of the year. With such studies as a basis for the development of understanding, prediction of precipitation within the area in question may follow.

The International Arid Lands Meetings and Conference were sponsored by the American Association for the Advancement of Science and the Southwestern and Rocky Mountain Division, AAAS, and were supported by the National Science Foundation, the Rockefeller Foundation, and the United Nations Educational, Scientific, and Cultural Organization.



Foreign participants in the International Arid Lands Conference. Left to right (back row) Mahmoud A. El-Ashkar (Egypt), Hilgard O'Reilly Sternberg (Brazil), B. P. Uvarov (England), Thomas C. Lermanda (Chile), Pedro Armillas (Mexico), N. L. Nicholson (Canada), Aldert Molenaar (FAO, Italy), James A. Swarbrick (UNESCO, France); (middle row) C. S. Christian (Australia), Carlos Muñoz (Chile), Rodolfo E. G. Pichi-Sermolli (Italy), Herbert Greene (England), S. N. Naqvi (Pakistan), C. C. Wallén (Sweden), E. G. Bowen (Australia), Georges Aubert (France), Enrique Beltrán (Mexico), Hugo Boyko (Israel), W. F. J. M. Krul (Netherlands), Theodore Monod (Senegal), Soubhi Mazloum (Syria); (front row) Omar Draz (Egypt), Kanwar Sain (India), E. M. Fournier d'Albe (Mexico), B. T. Dickson (Australia), F. Dixey (England), Michael Evenari (Israel), Jean Tixeront (Tunis).

9) Inasmuch as the matter of the evaluation of the results following attempts to modify weather and weather processes is recognized as offering great possibilities for the peoples of arid lands, every effort should be made to develop improved techniques for statistical evaluation of weather-modification experiments and to use the best available present techniques and data in the analysis of the results of such experiments.

10) An international cooperative program of synoptic observations should be instituted to determine the concentration of ice-forming nuclei throughout the world, especially during periods of the earth's passage through meteoritic streams. These observations should be supplemented by measurements, synoptic if possible, of the concentration of naturally and industrially induced condensation nuclei (including giant hygroscopic nuclei) by studies of the chemical composition of precipitation and by the conduct of cloud surveys.

11) A more vigorous study of all possible aspects of periodic cloud seeding is imperative.

12) Present knowledge of nucleation properties of silver iodide as affected by the methods of generation and dispersal is inadequate. Further studies, with particular reference to the decay of silver iodide's nucleating activity with increasing time of exposure in the atmosphere, are recommended.

13) Closer integration of the sciences of climatology and hydrology can be fostered through better exchange of information and collaborative analyses aimed at improving joint methodology. The lack of such collaboration between climatologists and hydrologists has contributed in the past to inadequate estimation of available water resources in some arid-zone projects.

Recommendations 17, 19, 25, and 29 are also applicable.

Hydrology, Geology, and Soils

14) The importance of ground water in arid zones calls for continued research on the following aspects of this subject: (i) methods of exploration and estimation of the volume of ground-water bodies; (ii) methods of increasing ground-water recharge and of estimating rates of recharge; (iii) the relation of vegetation and other biological factors to ground-water recharge; (iv) the geomorphological aspects of the occurrence and chemistry of ground water.

15) The precipitation occurring on drainage basins should not be regarded in terms of utilization for irrigation alone, and more consideration should be given to planning for the beneficial use of water that is not reaching points of downstream use.

16) Continued study is needed of the factors and practices modifying soil structure under various land-use practices, such as grazing, dry-land farming, and irrigation farming, recognizing the importance of soil structure and its maintenance in relation to permeability and to prevention and abatement of erosion.

17) The work of hydrologists and climatologists would benefit greatly by the fullest possible use of vegetation studies, specifically by the consideration of the role of vegetation as a factor in the hydrology of dry lands and of plant species and communities as indicators of climates, past and present.

18) Further attention should be given to the study of the geomorphic dynamics of landscapes for application to regional

and land-type appraisal and land-use planning.

Also see recommendations 13, 21, 25, 28, and 30(ii).

Biology, Ecology, and Conservation

19) Intensive studies of the microclimatic environments of plants and animals should be encouraged and pursued. The relationships between the data usually recorded by meteorological stations and the microclimatic effects of these phenomena in different sections of typical arid environments should be subjected to intensive study.

20) Research on plant and animal ecology, improvement, and management in arid areas should be intensified. Emphasis should be placed on preadapted species and races, on understanding of the physiological factors in the selection of characteristics desired in breeding, on water requirements of the various species and breeds as related to production, and on utilization of available soil and climatic resources by plants and of available vegetation by various species and breeds of animals.

21) Additional research is needed on the methods of determination and the estimation of the water requirements of plants in arid regions, especially on the efficiency of transpiration, the relationship between transpiration and photosynthesis, and the regulation of transpiration. The suggestion is made to the UNESCO Advisory Committee on Arid Zone Research that it compile a review of information and research studies currently available on this subject.

22) Intensified research should be undertaken, and research results should be applied in the management of grazing, because of the paramount importance of grazing management in the conservation and improvement of arid grasslands.

23) A thorough investigation should be made of indigenous plants of arid and semiarid regions with a view toward determining their usefulness and adaptability to grazing and cultivation.

24) There is reason to believe that studies of pharmaceutical and industrial uses of desert plants would be justified.

25) Intensified studies should be made on the formation, measurement, and utilization of dew to determine its potentialities as a supplement to rainfall in arid regions. Such studies should encompass the utilization of dew by plants and the selection of plants most efficient in such use; the relationship of dew to soil moisture; and the establishment of physical relationships for extracting dew from the atmosphere.

26) Natural arid-land ecological communities of indigenous animals and plants in their original habitats are essential for educational and scientific purposes. Areas of adequate size should be acquired and preserved in the various arid-land countries.

Also see recommendations 1, 2, 3, 14, 16, 17, 18, and 30(i, ii).

Organization, Communication, and Interdisciplinary Programs

27) The UNESCO Advisory Committee on Arid Zone Research is urged to revise and reissue its list of national and international scientific institutions concerned with arid-land problems. The revised list should be as comprehensive and as up to date as possible and should include addresses and fields of interest in order to serve effectively for intercommunication among workers in various disciplines.

28) Permanent cooperation in connection with studies on the demineralization of salty and brackish water should be maintained among the UNESCO Advisory Committee on Arid Zone Research, the U.S. Saline Water Conversion Program, and Working Party No. 8 on demineralization of salt and brackish waters of the Organization for European Economic Cooperation (OEEC) with the objective of adapting technical possibilities to local needs and economic resources.

29) Interdisciplinary studies should be promoted in order to sharpen the concepts used in defining, delimiting, and classifying arid and semiarid lands, with special emphasis on the variability of precipitation.

30) A demand for the application of scientific and scholarly knowledge in arid areas should be created by means such as those indicated in items i–iv. It should be noted that in many situations the driving force necessary for getting available knowledge applied to improvement of land and water utilization is lacking. This driving force is essentially public demand or social pressure. Creating such demand is the most effective method of attaining the desired end. (i) Expansion of demonstration areas, even though they have some disadvantages. They stress management by practical operators, such as commercial or family farmers, where demonstrations of practical value are sought. However, demonstrations designed for the promotion of specific understanding of resource problems and techniques by business and political leaders, and even by technical men themselves, should be maintained. Cooperative interdisciplinary demonstrations on single resource-management problems are useful. They have been successfully extended to include treatment of the entire resource pattern in areas of some size. Complex demonstrations of integrated resource management on a scientific basis not only are proved but deserve more intensive use. Demonstrations may be supported entirely by public funds, partly by public funds, and entirely by private funds. The possibility of extending the usefulness of the demonstration technique under private auspices is a relatively new subject that deserves further attention. (ii) Research in the social sciences, exploring limiting factors that have tended to keep knowledge from application. Much more knowledge is needed concerning the social and economic factors that influence the development and application of science, and concerning the art of persuading people to take action in resource development to their own and their community's long-term benefit. Special attention should be paid to economic and social studies that can throw light on the relative values of competitive uses of water. However, the cooperation of engineering and natural sciences in such investigations will be essential, together with the collaboration of geographers and anthropologists. (iii) Enlistment of local leadership and local interests in support of both basic research and practical studies designed to advance present knowledge and to transfer such knowledge into a form for direct application. Local groups will profit by taking an active part in and by supporting these programs. In many fields in some parts of the world institutes have developed techniques for enlisting the aid of private industry in some broad public programs. These techniques may be applicable in areas other than the limited ones where they have been applied up to the present, but applications will vary with cultures and local conditions. (iv) Greater attention by scientists to their relations with the press, radio, television, and other channels of public information. Such relations involve an opportunity and a dual responsibility—responsibility to science for the presentation of an accurate and complete report and to the particular audience for framing scientific material in a form that will most effectively reach the public whose interest in resource development they hope to arouse and to inform. Also, more attention should be paid to the art of communication and its demands in the training of scientists.

31) More effective interdisciplinary pooling and dissemination of information should be developed for the purposes of advancing science, as well as public understanding of scientific matters, by the following. (i) Establishment of local and national committees on arid-zone problems to enlist public interest in support of studies of arid lands and the dissemination of information on results of such studies in each country. The nature of

such committees and their method of formation ought to be locally determined in order to meet special conditions in each country, but it is strongly urged that they be broad in scientific disciplines and in representation from both private and public agencies. These committees should operate in a manner best suited to the interests and possibilities of each country and should be aimed at encouraging research and spreading information, utilizing UNESCO as a clearinghouse in this field. (ii) Creation of a preliminary project to explore the feasibility of an abstracting service on arid-zone literature. A periodical, patterned after existing successful abstracting journals, would include, as soon after original publication as possible, abstracts of technical, economic, and social literature related to arid-zone problems and research. Consideration should be given to the desired business and production organization, the volume of material to be included, the subject-matter divisions, the availability of abstractors, the cost of publication, the required subscription price, and so forth. A target date for the report on this feasibility study should be 1 year from the adoption of this recommendation by some agency capable of committing funds. (iii) Encouragement of the formation of research organizations, comprehensive in discipline and concerned with the best use of specific limited resources. Such organizations should be encouraged in all arid lands through adequate and broadly based financial support and through organized community interest.

Also see recommendations 2, 3, 4, 5, 10, 13, 18, and 21.

Comments on these recommendations will be welcomed. They should be addressed to John A. Behnke, AAAS.

The Grand Theme of Stephen Polyak

Stephen Polyak, who died in his home in Chicago on 9 March, was one of the great neuroanatomists of our time, destined to outlive the brief span of his 65 years in monumental contributions to the knowledge of the visual pathways, particularly the retina. To the excellent appreciation by his colleague anatomists in the *Journal of Comparative Neurology,* some words by a physiologist can only add the perspective created by distance of approach to his research and emphasize its general significance.

Polyak contributed important papers to the histology of the brain, its afferent pathways as well as the cochleo-vestibular end organs, and was one of the foremost experts on the microscopic anatomy of the central nervous system. Like the greatest of his teachers, Ramón y Cajal, he became fascinated by the histology of the retina. But, whereas Cajal began with the retina, describing it in his autobiography as the oldest of his laboratory loves, and then proceeded to investigate the same types of cells in other parts of the central nervous system, Polyak's research went in the opposite direction, from the central nervous system down to its projections in the retina. Captivated by this, the noblest of our sense organs, he wrote: "The study of the retina, begun almost by accident, stimulated me to experiment with different methods and material, including human eyes, and led to my systematic reading of the literature pertaining to the anatomy of the eye and the physiology of vision. This, in turn, caused me to do more research and to conduct further experiments, until, submerged as I was in this work, I almost lost count of the years that seemed to be passing by like months, while the notes and the figures were accumulating into an ever-increasing pile. . . . Indeed, from a casual problem my program developed, in the course of a few years, into a grand theme—big enough to fill a lengthy life." It filled 30 years of his life, a period of increasing technical perfection, happy creation, and penetrating scholarship. It took him back again to the central projections of the visual pathways and culminated shortly before his death in a book of some 1600 pages on *The Vertebrate Visual System,* now being posthumously edited by H. Klüver of the University of Chicago.

Polyak, a Jugoslavian by birth, survived innumerable vicissitudes of World War I—imprisonment, fighting, disease—to find himself, a young physician interested in neurology, being taken care of by the Rockefeller Foundation as a research fellow studying in London with G. Elliot Smith (1924–25). In 1925 he worked in Madrid under Ramón y Cajal. His association with the University of Chicago began in 1926 in collaboration with C. Judson Herrick and K. S. Lashley. In the meantime his position at Zagreb was given to a colleague and so he returned to the United States, this time as assistant professor of neuroanatomy in response to an invitation by the University of California. In 1930 he went to the University of Chicago, serving in turn as assistant professor of neurology, associate professor of neurology (1932–37), and finally as professor of anatomy until his death. It is to the everlasting credit of this institution that it supported for a quarter-century not only Polyak's research but also the scholarly publications in which he synthesized the whole literature on the visual and other afferent pathways. The posthumous work, completed in a race with death, will contain approximately 10,000 references.

Attitude no less than achievement serves to characterize a scientist, and by both criteria Polyak ranked high. In the words quoted here he emerges, true to life, as a lone worker rather than as partner of a team or leader of research groups, a man intent on devoting his life to what he felt to be a "grand theme." Everything related to this theme had to be considered and penetrated. He became an unrivaled master of the Ehrlich technique and the Golgi silver chromate stain, an expert on the history of physiological optics, and a competent judge of present-day neurophysiological modes of approach to the subject of vision.

His book of 1941, *The Retina,* was immediately hailed as a classic. It gave the first complete description of the primate retina and was based on thorough research. Several new discoveries related to the synaptic organization of the retina, especially the amacrine and bipolar cells and the centrifugal pathways within the retina, were announced. He described the midget bipolars and, in this connection, the different mono- and polysynaptic organizations of cone and rod pathways and showed that the two types of receptor also have paths in common, as has since been amply borne out by physiological studies. For generations to come his work will be the leading source of reference for those interested in the way in which the retina collects and elaborates information for delivery to the higher centers.

The solitary worker may receive few honors—and Polyak had few if any—but may nevertheless by his attitude and achievements create values that the scientific world does well to remember.

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