The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the World Meteorological Organization concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.
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The Third WMO Long-Term Plan, for the period 1992-2001, was approved by Eleventh Congress by its Resolution 28 (see annex). The Plan comprises Part I - Overall policy and strategy, and Part II, in seven volumes, covering the plans for the scientific and technical Programmes of the Organization.

This volume deals with the Technical Co-operation Programme. The success and effectiveness of WMO's programmes will depend on the ability of all national Meteorological and Hydrological Services to participate actively in them. Congress thus strongly supported the strategic approach to technical co-operation through which WMO promotes the development of human resources and systems through transfer of knowledge, technology and proven methodology to the national Services of the developing countries. The goal must be to increase the abilities of these countries to benefit from, and contribute effectively to, the programmes of the Organization. WMO technical co-operation activities over the next decade must involve renewed efforts to "bridge the gap" between the developing and developed countries in order to ensure that the Services in developing countries are able to provide at least the minimum level of services required of them in support of economic and social development.

The Plan was adopted under the provisions of Article 8 (a), (b) and (c) of the WMO Convention by which Eleventh Congress:

- Approved the general policies stated in this Plan for the fulfilment of the purposes of the Organization;
- Recommended to all Members that they should fully take into account the Plan in developing and carrying out their national programmes in meteorology and operational hydrology, as well as in their participation in the Programmes of the Organization;
- Referred to the constituent bodies of the Organization those tasks within their terms of reference for appropriate action in order to achieve the objectives of the Plan.

Thus, the Plan has the status of a recommendation as far as Members are concerned. Nevertheless, it is understood that only with the full participation of all Members of the Organization will the long-term objectives of the programme be achieved. Therefore, the Plan is commended to all Members as a basis for mobilizing efforts towards achieving the objectives of the Organization.

(G.O.P. Obasi)
Secretary-General
TECHNICAL CO-OPERATION PROGRAMME 1992-2001

INTRODUCTION

1. The range of meteorological and hydrological and related services available to policy-makers, planners and citizens in many developing countries to assist in economic and social sustainable development and in the carrying out of day-to-day weather- and water-affected activities is much smaller than that available in many industrially developed countries. This lack of services, or range of services, is attributable not only to a lack of trained personnel, or a lack of awareness of the value of services but also, at times, to the lack of basic observations from which services are derived. The Technical Co-operation Programme has been developed to help Members of WMO help each other to overcome difficulties in operating a national Meteorological and Hydrological Service, in the development of facilities or services, and in the provision of services.

2. WMO's technical co-operation activities must seek to bridge the gap between the services provided in the developing countries and those in the industrially developed regions. It should be emphasized that this does not mean that all countries must have similar sophisticated computers, communications systems and instrumentation. Rather it means that WMO's objective is to ensure that the level of services provided to policy-makers, planners and citizens is raised in the developing world in order to contribute effectively to economic development and to the safety and security of citizens. The raising of the level of services can be achieved in part through efforts of individual countries, but in many cases co-operative efforts of a regional nature between a number of countries can achieve the most cost-effective results. Such co-operative efforts can involve the establishment of regional specialized centres for operations and training, improvement of communications networks, or, as recently agreed in South-East Asia, co-operation in the marketing of meteorological products.

3. It must also be emphasized that there is a close interdependency between meteorological services of the world and between hydrological services within an international basin. In meteorology, all countries, large and small, developed or developing, are dependent upon the observations and communication of data from other countries. Similarly, in the Global Data-processing System, Regional and National Meteorological Centres are dependent upon one another and on the World Meteorological Centres for data processing and production of essential products ranging from analyses through prognoses to tailored forecasts. In this sense technical co-operation in meteorology is for everyone a self-help activity. A river basin that encompasses more than one country requires special co-operation between nations and emphasizes the interdependency of hydrological services within an international river basin.

Purpose and scope

4. The purpose of the Technical Co-operation (TCO) Programme is to advise and assist in the strengthening of the national Meteorological and Hydrological Services of developing countries, through the transfer of knowledge, technology and proven methodology, in order to improve the effectiveness of these Services in support of economic and social progress.
5. The availability, quality and nature of weather and hydrological services are increasingly recognized as keys to developing and sustaining national economies as well as to the safety, security and well-being of a country's citizens. The major developments and progress foreseen for the next decade in the World Weather Watch (including aviation, marine meteorology, and tropical cyclone programmes) supported by the Global Telecommunication System, in the World Climate Programme, in agrometeorology, in hydrology and water resources, in environment, and in research and development fields are outlined in Part II, Volumes 1 to 6 of the Third Long-term Plan (TLTP). At the same time, the developing regions of the world have been assessing the state of the meteorological and hydrological services that can be provided in their regions, and the impediments to achieving levels of service which will make optimum contributions to economic development and to the safety and security of populations.

6. The analyses of regional needs and the development of the WMO Long-term Plan together provide a basis for examining priorities in technical co-operation programmes managed by WMO in order that these programmes may make a maximum contribution (a) to achieving suitable levels of weather and hydrological services in developing parts of the world and (b) to reaching the collective goals of the agreed WMO programmes. This strategic approach to technical co-operation is a first attempt to articulate such priorities, in the hope that it will (i) guide donor agencies and countries in contributing to meeting the most important needs, (ii) help the countries receiving assistance to identify and obtain support for technical co-operation projects that will yield maximum benefits, and (iii) assist the WMO Secretariat in assigning priorities in its activities.

Overall objectives

7. The overall objective is to provide and operate effective mechanisms for helping Members, especially in developing countries, to implement adequate levels of service for national development within the framework of the WMO Long-term Plan.

8. There are also specific overall objectives at national, regional and global levels which are defined in the following paragraphs.

National objectives

9. To assess objectively where technical co-operation projects are most essential, some idea is needed of the required level of services to provide for safety and security of populations and support to economic development. However, it is difficult to define such required levels of services in the abstract. For example, the services required in a country with abundant water resources are different from those required where lack of water severely limits development, and a region whose economy depends heavily on agricultural production has different needs from one with a mainly mineral-producing or manufacturing economy.

10. Nevertheless, there remains a common base of activity that is necessary in order to sustain and develop any economy, and there are basic services required for the safety and security of citizens of all countries. Each country requires severe weather warning and forecasting services; a record of the climatic conditions in each major region and a means of
providing such climatic data in forms of value to many users; a measure of available water supplies and of highest and lowest river and lake levels, and flows, at key locations and points of water use. To provide these services and data requires the establishment and maintenance of an infrastructure consisting of weather and water observation stations, communication facilities, forecast office(s), data-handling facilities, training facilities and planning and management functions. These basic services are described more fully in the following sections.

Meteorological services

11. Meteorological services include, as required, the following capabilities:

   (a) Warnings of severe weather from tropical cyclones, thunderstorms, tornadoes, hail, strong winds, heavy rain, ice storms, heavy snowfalls, etc. For marine areas, warnings of high winds, heavy seas and sea ice and icing are required;

   (b) Forecasts of weather elements (at least precipitation, temperature, sky cover, visibility and wind) issued one to four times daily for each major city, airport, agricultural region and marine area (including, in addition to the parameters listed above, sea surface temperature and sea conditions) on which shipping, boating or fishing activities occur.

   (c) To achieve (a) and (b) requires the following five capabilities:

      (i) Weather observations available in real time at least every six hours at all major airports, centres of population and from regions not otherwise covered by WMO recommended network density and standards of observations for synoptic weather stations;

      (ii) Observations of upper atmosphere, pressure-height, temperature, humidity and wind at various specified levels in accordance with WMO recommended network density and standards of observations;

      (iii) A communication system which permits:

      - Collection of real-time time data at (a) central office(s);

      - Communication connections at a rapid speed (preferably at least 2400 baud), from the country's central office(s) to those of adjacent countries to receive data and processed information from other countries and to transmit data to other countries in accordance with the WWW Global Telecommunication System;

      - Rapid dissemination of warnings, forecasts and real-time data to major users and to the public media for more general use.
A weather satellite data reception facility for at least
geostationary, and preferably for both geostationary and
polar-orbiting satellites;

In regions where thunderstorms, tornadoes and tropical
cyclones are frequent, weather radar facilities for storm
detection and tracking.

12. Also required is a more dense network of observation stations than the
synoptic network for precipitation and other climatological elements from
which data are collected at (a) central office(s) at least once a month.
Network density standards for such observations, as recommended by WMO, are
given in the abridged report of Cg-X, general summary, paragraph 3.2.1.2
(WMO-No. 681).

13. Staff and/or computer facilities are required to check the quality of
data from all networks, establish an archive of all such data in a form which
ensures permanent retention and rapid access to the data. If more than two
dozen stations are involved this work can best be accomplished by
microcomputer or larger facilities. Records must be retained in original
paper copies until retention and storage are assured by more permanent records
on microfilm, microfiche, etc., and where possible on magnetic tape or disk.

Hydrological services

14. Hydrological services include, as required, the following capabilities:

(a) Daily or continuous measurements of water levels on all
significant lakes and rivers especially at points of large
population, significant actual and potential uses (irrigation,
power production, water supply), confluence with other water
bodies, and at national or sub-national border crossings.

(b) Periodic flow metering (at least twice per year where sections
are not stable) at a sufficient number of the water-level
measuring stations over a range of water levels, to permit
determination of instantaneous flows and volumes on each
significant river and tributary. A sampling of rivers flowing
from small tributary basins is also required;

(c) Sampling at least once a month and during significant flood and
low-flow events at fixed points on major rivers for water
quality and sediment transport monitoring;

(d) Staff and laboratory facilities to analyse water quality and
sediment samples;

(e) Staff and/or computer facilities to check the quality of such
data, and establish a databank in a form which ensures rapid
access to the data;

(f) The capability to analyse the data for means, extremes and
probabilities, of flows and levels, for assessments of water
availability, flood and drought frequency and severity.
15. Where serious floods can occur, and/or intensive water use, or apportionment arrangements between countries require careful sharing of water, forecasts of river flow and water level are required. This necessitates real-time communication of water-level data to a central site and an arrangement to collect real-time precipitation and other meteorological data directly, or through arrangements with meteorological agencies. In addition mathematical models which permit flow and water-level prediction from meteorological and hydrological data must be developed, calibrated and readily available for use either in computer form or in simple cases in the form of manual or graphical forecasting procedures. In some cases, very simple graphical forecasting procedures can give valuable results.

16. Where groundwater is exploited intensively, well-water levels should be recorded at some wells, strategically located to determine the replenishment or draw-down of important aquifers.

Assessment of climate and climatological services

17. Climatological services include the capability to analyse such data as means, extremes and probabilities of weather and climatological events for use in many engineering, economic and planning activities.

18. Elements to assess climate and climate change include:

(a) The monitoring of greenhouse gases with the important potential effects on the climate. These are carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), surface ozone (O₃) and chlorofluorocarbons (CFCs). Currently, except for CO₂, there are only scattered measurements, which are not sufficient for establishing reliable trends and projections for the whole of the atmospheric composition change and the consequent effects on regional and global climate.

(b) Improvement of ozone observations and re-evaluation of ozone data records. Atmospheric ozone is one of the first atmospheric components which was proven to be severely affected by emissions of substances produced by human activities. For 33 years WMO has been guiding and co-ordinating the Global Ozone Observing System, consisting of more than 150 stations and supplemented in the last decade by a few satellite observing systems. There is, however, a need for widespread efforts on a global scale to improve the available information in order to better judge behaviour of the ozone layer and its potential further destruction.

(c) Availability of high-quality, reliable climatological observations in the form of standard data sets. WMO has undertaken two projects aimed at ensuring that data are available and easily accessible to users including atmospheric scientists – namely, CLICOM and INFOCLIMA.

19. Even a relatively small shift in the global precipitation belts can produce devastating effects on economies and populations especially in the case of a reduction in water supply in countries, especially small ones, bordering the tropical and sub-tropical deserts and downstream areas. On the other hand, more intense precipitation can result in severe floods endangering
the safety of some of the hydraulic structures. The rapidly expanding urban areas in developing countries with rudimentary drainage systems are very sensitive to increases in magnitude of rain storms and changes in frequency of these storms. It is important for countries to study all available records of climatological and hydrological data so as to assess the likely impact of climate variability and change.

20. It must be recognized, of course, that the above activities cannot be planned or carried out without the appropriate institutions, meteorological and hydrological agencies, or combined hydrological/meteorological agencies, and the trained personnel needed to discharge the above functions within such agencies. In connection with the latter point, education and training must be seen as vital components of major technical co-operation projects, and steps must be taken to ensure the retention of trained staff in the provision of weather and water services.

Regional objectives

Africa

Major weather events of concern to Africa

21. Outstanding among these are the drought which affected 34 countries during the period 1982-1984 and the tropical cyclones of the South-West Indian Ocean which threaten some ten countries of Africa.

22. Other weather events are generally less widespread and devastating but nevertheless important on a national or sub-regional scale. These include the Mediterranean cyclones that affect North Africa, the tropical cyclones that affect the south-eastern part of the continent, squall lines of West Africa, dust, haze and sandstorms. Departures from normal of the monsoons of East and West Africa and the "Zaire Air" of south-western Africa can be closely related to development of drought or flood conditions.

Impediments

23. It is recognized that the development of meteorology, which has not hitherto been regarded as having high priority in many national budgets, is intimately linked with the level of economic development of a country. Thirty of the 51 countries in Africa have been designated as among the least developed countries of the world. In a detailed analysis submitted to the UN Special General Assembly on Economic Crisis in Africa in May 1986, the Region was divided into seven areas. It was noted that the countries with the weakest economies were those in the drought-affected and cyclone-prone areas. This is surely not entirely a coincidence - the economic disruptions due to such natural disasters undoubtedly make steady economic progress very difficult. Indeed, a direct, high correlation is evident between annual economic (largely agricultural) production and rainfall amount in most countries of this group. Programmes to predict and minimize effects of these natural disasters can play a key role not only in saving lives and property but also in minimizing economic disruptions.

24. Competition for funds at national level is very great and meteorological products must be shown to have a multiplier effect to ensure that resources are made available from national budgets or external sources. Hard facts and examples of the benefits of weather and hydrological services
must be widely disseminated. Some of the least developed countries have the
basis for good, viable meteorological services - most likely because the
usefulness of the service has been recognized. Consciousness of the role of
meteorology has been greatly increased in the wake of drought and cyclones.
The often-repeated advantages of meteorology and ACMAD are generally accepted
in the fora of politicians, economic planners and decision-makers at the
Economic Commission for Africa. The challenge now rests with meteorologists.

25. Concerning hydrological services, few countries have a sound basis to
build upon. There is a need to strengthen these services in many of the least
developed countries.

Continental and regional deficiencies

26. In addition to the national infrastructure requirements suggested in
the above analysis, Africa does not yet have fully developed continental,
regional and sub-regional centres. Reliable and fast communications networks
required to provide a full range of weather and drought warnings and services
are available only for a relatively small portion of the continent. Systems
for forecasting the flows of multi-national river systems and providing flood
warnings are operational in only a few cases, e.g. Niger River.

27. Major African regional requirements are as follows:

(a) Adequate observational networks for meteorological and
hydrological elements as outlined under the section on minimum
services;

(b) An effective regional satellite-based communication system,
permitting real-time collection of data at a regional centre and
special sub-regional centres, readout or transmission of
satellite images to all national centres and reception at
national centres of analysed products from regional and
sub-regional centres, and reliable high-speed (at least 9600
baud) communication circuits to Europe and Asia;

(c) A major regional centre (ACMAD) for continental weather and
drought watch, medium-range weather prediction, dynamic
climatology and continental-scale development of agrometeor-
ological and hydrological applications and supporting research.
Operations started in 1991 with contributions from donors and
Member countries. The budget for the first five years is
estimated at 22 million dollars;

(d) Maintenance or development of existing specialized sub-regional
operational centres (AGRHYMET, Niamey, Niger), drought-
monitoring centres (Nairobi, Kenya; Harare, Zimbabwe), and
HYDRONIGER Centre (Niamey);

(e) Development of new sub-regional centres in the South-West Indian
Ocean region for tropical cyclone warning and prediction, in
southern Africa for drought monitoring and in the Zambezi River
Basin and in other important international basins for river
forecasting and water analyses;
(f) Strengthening of the Regional Meteorological Training Centres (Antananarivo, Cairo, Lagos, Luanda, Nairobi, Niamey (2) and Oran) through the introduction or bolstering of specialized training courses (for example: in agrometeorology, hydrology and marine meteorology) which cannot be readily met at the national level.

National requirements

28. According to the information available, 22 countries do not, or barely, meet a minimum level of development of service. In those which do, the challenge is to exploit that capability for maximum social and economic benefit - e.g. through effective specialized services to agriculture, water management, transportation, energy production and distribution, environmental review, and industrial development. The main areas of development are:

(a) Telecommunications:
   (i) Capability to collect real-time data within the country - assistance needed in 26 countries;
   (ii) Transmission of data to and from Regional Telecommunication Hubs - 28 countries need assistance;
   (iii) Equipment for transmission of data to continental centres and for receipt of analyses, forecasts and products from ACMAD - all countries;

(b) Climate data management and applications to energy, agriculture, water and transportation: Phase I CLICOM systems installed or promised in 30 countries. CLICOM systems should be installed in all countries and the applications Phase II stage must proceed rapidly in those countries in which Phase I systems have been installed;

(c) Climate data rescue (ensuring long-term safe storage and retrieval of climatic records) (DARE). Completed in eight countries. Assistance is needed in 42 countries;

(d) Agrometeorological forecasts and bulletins are currently issued in 16 countries. There is a requirement for these forecasts to be developed and issued in 34 additional countries;

(e) Improvement in aviation and marine forecasts for safety of aircraft and boats (fishing, transport) required in about one half of the countries;

(f) Hydrological data-collection networks in 30 countries and data-management systems in 25 countries;

(g) BAPMoN stations for monitoring air and precipitation pollution required in approximately 20 additional locations to add to the present network of 10 locations;

(h) Development of national training facilities in 13 countries to meet their own Class IV training needs.
Asia and South-West Pacific

29. Most of the countries in Asia and the South-West Pacific encounter not only the vagaries of the monsoon but are also affected by tropical cyclones, typhoons and tropical disturbances. The minimum level of services must, therefore, include reliable storm and flood forecasts and warnings adapted to the needs of each locality. In addition, aviation meteorology and forecasts for marine areas for shipping and fishing are of fundamental importance to these countries. The minimum level of services as defined earlier is required throughout the Region.

30. The basic infrastructures needed to support these capabilities are the observational networks, communications facilities and institutions outlined in paragraph 11.

31. In general terms, most of the Members in RA II and RA V have developed the basic infrastructures for meteorological and hydrological activities to meet operational needs, particularly for aviation. Many, however, find it difficult to maintain these infrastructures or to make improvements. On the other hand, in a smaller number of countries, even the basic supporting capabilities are lacking.

Metereological Services

32. In RA V most countries have achieved the minimum level of services as defined to meet national requirements and with some enhancements their performance could be improved. Of late, however, the lack of funds for spare parts and the replacement of old equipment has presented operational problems in some of these countries. However, some countries such as the small island States of the South-West Pacific need extensive support to bring the level of meteorological services to the minimum level. Fiji, however, is progressing well in improving its meteorological services and is considered by many to be the most advanced among the South-West Pacific island States.

33. In RA II several countries have relatively advanced meteorological and hydrological services. Most countries have the basic structures to provide meteorological support for aviation but are unable to achieve the optimum use and proper maintenance of existing facilities due to the lack of national resources for spare parts, consumables and for the replacement of old equipment. In this regard, some countries are unable to develop their capabilities to meet the minimum level of services required. The Middle East countries of RA II are capable of meeting national needs for meteorological support principally for aviation. There are, however, varying degrees of deficiencies in some aspects of meteorological activities. The shortage of trained local personnel appears to be the major obstacle to the advancement of meteorology in certain of these countries, resulting in a continued dependence on foreign private companies to provide meteorological services.

34. In addition, only a few Meteorological Services have adopted an open approach in providing user-oriented services other than traditional weather forecasts. To the detriment of the Meteorological Services, in some countries, the flood-forecasting services have installed their own meteorological facilities, including satellite link-ups, and are planning to install rainfall-radar systems. There is a serious need for encouraging the national Services to promote inter-agency co-operation and thus avoid duplication of effort.
35. A major impediment detrimental to the development and advancement of national Meteorological Services in developing countries is the relatively low status and priority sometimes accorded to meteorological activities. The two main factors contributing towards this impediment are: (a) the inadequacies of demonstrations of the practical relevance and importance of meteorology in national development, and (b) the limited size and influence of a national clientele to enhance the image of the national Meteorological Services because of the lack of specially tailored products for end-users. The lack of national resources in certain countries and the recent global economic recession have compounded the effect.

36. The main contributing factors to this situation, for which corrective action should be taken, are:

(a) Lack of awareness by national planners of the role and relevance of meteorology in national development;

(b) Products not tailored to the need of end-users due to lack of close interaction with users of meteorological data. Hence, the potential and relevance of meteorological data to a wide range of human activities are not understood, or fully exploited;

(c) Lack of "marketing skill" in the promotion of meteorological and hydrological applications on the part of these agencies;

(d) The difficulty in some cases of quantifying economic benefits in real terms as against expenditures;

(e) Limited availability of practical demonstrations on how meteorological inputs could help achieve better and more successful planning and implementation of economic development projects and other human activities.

37. National Meteorological Services traditionally provide essential weather forecasting services, particularly to aviation. The opportunity to train staff in specialized fields is often unavailable due to the lack of resources and manpower. Long years of climate records are often not fully put to proper use because of the lack of trained staff to develop appropriate end products for users. There is also a lack of resources for the improvement and modernization of climate procedures such as the introduction of data-processing by computers, e.g. CLICOM systems. Effective climate-service support as well as consultations and specialized services are therefore often lacking as inputs to the planning and implementation of national activities.

Hydrological Services

38. In most of the countries of the Region devastation due to river floods as well as storm surges is an all too frequent occurrence. While flood forecasting on major rivers is marked by reasonable progress, greater attention is needed for the prevention of losses from flash floods which take a large toll, especially in urban areas. Improved hydrological forecasting for flood warnings and hydrometric programmes are essential to minimize loss of life and damage.
39. In general terms the situation of hydrological data collection, forecasting, storage and retrieval activities in Regions II and V has continued to improve and a number of countries now have databank facilities for water level, discharge and precipitation data. A great number of countries, however, do not have national hydrological databanks and many still lack computing facilities for data storage and retrieval.

South and Central America and the Caribbean

40. The degree of development of the Meteorological and Hydrological Services in South and Central America and the Caribbean varies widely from country to country. Most of the Meteorological Services were created at the end of the last century or at the beginning of the present one, in many instances in conjunction with astronomic or geodesic activities. The scope of the services provided in meteorology was rather limited, but in most of the countries one or more complete stations were installed. A hundred or more years' information is now available at a number of stations providing valuable data of good quality.

41. With the development of aviation, both co-operation between Services and the quality of weather forecasting increased. Most of the Services maintained relatively good climatological records which were periodically published in yearbooks. This information covered only the developed zones of the countries, leaving large areas, e.g. the Amazon, the Atlantic coast of Central America, with little data.

42. The creation of the United Nations Special Fund and its successor, the United Nations Development Programme, promoted many projects for the development of meteorological and hydrological observing networks. The first projects were in Chile, Ecuador, and Peru followed by projects in Bolivia, Central American Isthmus (Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama), Colombia, Paraguay, Uruguay and the English-speaking Caribbean.

43. Further development of Services was closely related to international co-operation programmes, mostly those involving WMO but some of a bilateral nature. A large majority of the Services have reached a stage where they are using the information provided by their meteorological and hydrological networks for development applications. In addition to those in support of aviation, inaugurated in the 'thirties, applications to agricultural production, energy generation, irrigation and civil protection are well developed in many countries. In parallel, most Meteorological and Hydrological Services have developed computerized data-processing systems and are increasingly using modern computer techniques for many of their other activities.

44. In spite of this progress, there are zones which still lack a basic observing network for two reasons:

(a) Inaccessibility or low economic development of the region; and

(b) Low development level of the national Services.

45. In the first instance, application of modern technology, such as automatic observing stations with satellite (DCP) transmission or advanced
remote sensing techniques, is required and, in the second, efforts for further development of the Services are needed.

46. Most of the present technical co-operation in the Region is in development of application programmes to ensure that greater economic benefits accrue from basic information available through meteorological and hydrological agencies. Technical co-operation for this will be required to a major degree for many years to come. However, progress to application of modern computers and techniques should commence immediately. In fact, some countries will have to cope with the activities of the three phases at the same time. Brazil, for example, still needs to improve its observing network in the vast Amazon Basin, is actively engaged in agrometeorological activities and is going ahead with the development of an advanced Centre for Atmospheric Sciences.

47. The major impediments to improving the level of the Services are:

(a) The almost exclusive application of real-time information to air transportation, an activity which normally has the necessary resources to support the Services in fulfilling their requirements;

(b) The resigned view that agricultural production depends entirely on the vagaries of atmospheric behaviour; lack of knowledge of the nature and benefits of agrometeorological techniques;

(c) The long waiting period required between initiating an observing programme and obtaining reliable and consistent statistics through patient and systematic data collection in climatology and hydrology;

(d) The other problems enumerated in paragraphs 29 to 39 for South-East Asia and the South-West Pacific.

48. These are all factors which have induced national authorities to postpone action in support of the Meteorological and Hydrological Services.

49. Another group of factors that has restricted the development of the Meteorological Services in the Region is related to the technical level of staff. The deficit in trained staff is relatively high from both the qualitative and quantitative point of view. This is a complex problem and for this reason it is necessary to describe it so that it may be analysed in detail and lasting solutions found. Within the environment in which meteorological and hydrological activities are performed, it is relatively easy for the countries to obtain fellowships or other means of providing their staff with a wide range of professional training. However, the generally low salaries, the economic restraints that prevent better remuneration of qualified employees and the personnel rules which do not motivate the upgrading of technical capacity lead to a constant flow of technicians and professionals from the Services to other national organizations, the commercial sector or to foreign countries. From the technical co-operation viewpoint this means a waste of resources, and for the Meteorological and Hydrological Services, the frustrating need for continuing permanent action in the training field. Only in exceptional instances has an action of massive professional training received political and economic support, in which case the development of the services and of meteorology at the national level has
been remarkable. WMO and the countries of the Region should devise new and imaginative large-scale training schemes to overcome this problem.

50. As indicated, there are still vast areas of the Region without adequate meteorological network coverage. This is due mainly to the size and inaccessibility of these zones. The use of conventional techniques to achieve the network density recommended by WMO will result in costs which are prohibitive. More and more use is made of modern technology, such as integrated databanks (the square grid study of the Amazon River Basin is a good example, although further improvement is needed), automatic stations and remote sensing. However, more effort in these areas is required. Projects similar to the DCP co-ordinated project and HYDRONIGER in Africa are needed to acquire observations from these Regions.

51. Clear demonstrations of the capability to apply meteorology and hydrology to development activities must accelerate. As for other Regions, although there have been some concrete results documented, more and better examples are necessary to convince economists and planners that the investment in meteorology and hydrology pays and successful efforts must be much more widely publicized. Meetings such as the Climate Conference at Paipa and the Santiago Conference on the Benefits of Meteorological Services are useful, provided that planners at decision-making level attend.

52. Except for Canada and the USA, all Members in RA III and RA IV require assistance for training their national personnel in meteorology and hydrology. Many countries have well-organized training centres for lower-level meteorological personnel and others have the capabilities for higher technical and professional training in meteorology or hydrology or both. Countries in the English-speaking Caribbean region have training capabilities available at the Caribbean Institute of Meteorology and Hydrology. All developing Member countries will continue to require assistance for training in specialized fields and in the application of newer technology.

53. Canada and the USA have well-developed and advanced meteorological services. In contrast, services in Latin America and the Caribbean are not equipped to derive the best benefit from data, information and products which can be made available to them under the WMO World Weather Watch system.

54. Based on a sound analysis of economic benefits and impacts, joint efforts should be made by the developing Member countries to adapt and provide regional analyses and prognoses as far in advance as possible to enhance their national capabilities in weather forecasting and warning systems and services for severe meteorological conditions and floods. Such joint efforts should include opportunities for national staff to engage in meteorological research programmes, including climatic variability and change, which individual countries cannot undertake separately. Both Argentina and Brazil have already a good start in this context and their experience should be most useful in developing regional facilities. In the meantime the efforts under way in the integrated VCP-UNDP project for improvement of telecommunications in South America and for upgrading ANMET and CEMET must be completed.

Global programmes

55. The matter of level of services is also closely related to the ability of countries to contribute to the programmes of WMO outlined in the Long-term Plan, both for their own internal benefit and to support the global effort.
Thus, this volume reviews the WMO programmes contained in the third Long-term Plan (1992-2000) and identifies the major problems in achieving its ten-year goals. It summarizes the programmes for the benefit of those readers who do not have ready access to the complete version of the Third Long-term Plan. The following chapters review the impediments to providing appropriate levels of services as described above from a regional perspective, thereby leading to identification of technical co-operation needs for meeting basic levels of services.

World Weather Watch Programme

56. The World Weather Watch (WWW) Programme is the most fundamental of WMO's programmes in that many activities in all programmes depend upon the successful implementation of the WWW. The Programme is implemented by the co-operative efforts of Members, but in a number of Regions and countries some external assistance is required and is provided to the extent resources permit through WMO and to a limited extent by bilateral donors. The WWW encompasses the observation of meteorological conditions by agreed standard methods over the globe, at the surface and aloft. The collection and dissemination world-wide of these data and the processing of the data produce analyses and predictions which in turn are widely distributed to and from nationally, regionally and globally designated centres.

57. The essential elements of the WWW system are:
   (a) The Global Observing System (GOS);
   (b) The Global Telecommunications System (GTS);
   (c) The Global Data-processing System (GDPS).

58. These are integrated into a single system by the WWW Data Management function and supported where necessary by WMO technical co-operation and implementation support activities.

59. The purpose of the WWW Programme is to ensure that all WMO Members have access to the meteorological and related geophysical information needed to provide effective services and conduct related research so that each may make the best use of its weather and climate and minimize their harmful effects.

60. The overall objectives of WWW are given in Part II, Volume 1 of the Third Long-term Plan, and are essentially aimed at the implementation and operation by Members of a world-wide integrated system for the collection, processing and rapid exchange of meteorological and related environmental data analyses and forecasts.

World Climate Programme

61. The World Climate Programme has four major components: the World Climate Data and Monitoring Programme (WCDMP), to assist in data management for climate applications; the World Climate Applications and Services Programme (WCASP), to assist in techniques for applying climatic data in all fields of
economic development; the World Climate Research Programme (WCRP), to develop methods for predicting future climatic conditions and to assess potential climate changes; and the World Climate Impact Assessment and Response Strategies Programme (WCIRP), to assess the social and economic impact of potential climate changes and to identify appropriate socio-economic response strategies that could be used by governments and the community. Most technical co-operation activities should focus on helping countries achieve basic levels of service in the first two categories of activity. However, some efforts will be increasingly required to assist in WCRP and WCIRP activities.

62. Two main projects, CLICOM (climate computation) and DARE (data rescue) within WMO technical co-operation activities in WCDMP and WCASP are described in the following sections.

63. **CLICOM project**: A capability for quality control, retrieval and analysis of climate data for many national services can best be met by the installation of CLICOM systems - based on microcomputers. The Phase I objective of the project is to transfer technology in comprehensive climate data-management and user services. The development of computer systems, data-management software and training programmes has been completed and the project is now in its implementation phase. Approximately 100 countries require CLICOM systems in order to efficiently manage their climate data and provide effective user services to the government, industry and public user sectors. About 40 systems have been earmarked for funding through VCP, UNDP and trust funds and the goal should be to make such systems nearly universal.

64. The Phase II component of the CLICOM project will focus on the incorporation of climate application software modules for agriculture, water resources, energy, urban climate, transportation, health, and other applications. Comprehensive state-of-the-art software is already available to allow meteorological services to become directly involved in decision-making for economic development. Stress will also be placed in Phase II on data exchange links with real-time WMO systems (World Weather Watch), the exchange of application software developed by users, and access to scientific research results. Many countries are ready now to move to Phase II projects.

65. **Data rescue (DARE) project**: In many countries safe storage, archiving and retrieval of old climatological records remain a problem. The DARE project is currently being implemented in Africa (WMO Region I). The project entails the transfer of data into durable microfiches and in some cases CLICOM-compatible digital datasets. Funding for a part of the African effort has been committed (by Belgium). To ensure continuing security for the data and access to the information, each country will need to be equipped with microfilming units and microfilm reader/printers. This project is planned to be expanded into RA II, III, IV and V within the next two years. This will require considerable support from Members.

66. Reduction of the effects of drought and desertification is also a priority programme. The application of this programme requires certain minimal institutional arrangements in most countries concerned. WMO actively promotes, through the Technical Co-operation Programme, the establishment of national agrometeorological services which should collaborate closely with the user-services, often through a formal or informal multi-disciplinary working group. Its long-standing commitment to encouraging collaboration between Hydrological and Meteorological Services also contributes to this objective.
WMO technical co-operation projects related to the World Climate Applications and Services Programme are generally associated with the following areas:

(a) Assisting Meteorological and Hydrometeorological Services to develop capabilities for climatic applications in food production, water resource management and the use of renewable sources of energy (such as solar and wind energy) as well as applications to conventional energy sources;

(b) Promoting applications of urban and building climatology as well as land-use planning for human settlements;

(c) Promoting the application of climate knowledge and information in the interest of human health.

Atmospheric Research and Environment Programme

68. The main purpose of the Atmospheric Research and Environment Programme is to foster and co-ordinate research in meteorology and related fields, with a view to enabling Members to provide better services in their areas of responsibility. The establishment and development of research departments in Services of Members and in appropriate regional meteorological institutions is an important goal. Transfer of technology is, however, the essence of the programme. The Global Atmosphere Watch (GAW), which integrates all activities related to environmental pollution monitoring, research and assessment, receives the highest priority efforts of the programme. Other major areas are weather-prediction research, tropical meteorology, physics and chemistry of clouds and weather-modification research. The Atmospheric Research and Environment Programme is described in Part II, Volume 3 of the Third Long-term Plan. The main area of interest is the Global Atmosphere Watch.

Global Atmosphere Watch

69. Within the GAW, there are four activity areas, each with its own specific objectives. These are outlined in the following sub-paragraphs:

(a) Global Ozone Observing System (GOOS), including ozone-related compounds; the improvement of accuracy in ozone and ozone-related trace gas measurements; the encouragement of the re-evaluation of past ozone records; the near real-time exchange of data for early warning of observed ozone changes; the preparation of scientific statements on the state of the ozone layer; the assistance in further investigations on the atmospheric chemistry-climate link;

(b) Global monitoring of background atmospheric composition including BAPMoN (Background Atmospheric Pollution Monitoring Network); the improvements of the network coverage and management, the observation programme, data quality, data
reporting and data publications; the promotion of utilization of BAPMoN data in the preparation of scientific assessments and authoritative statements on the various parameters and in addressing global, regional and national concerns (e.g. climate change, acid rain);

(c) Transport and dispersion of atmospheric pollutants on different time and space scales: the development, utilization and optimization (scientifically and economically) of numerical models capable of predicting changes in atmospheric composition and the long-range transport of pollutants for use in support of the GAW system, in the implementation of the meteorological aspects of the ECE/WMO/UNEP EMEP programme and in addressing problems of long-range transport of pollutants and of acidifying deposition; the keeping abreast of developments in short- and long-term modelling of air-pollution forecasts and in the use of boundary-layer parameterizations and three-dimensional weather-prediction models for this purpose; the stimulation of the development and evaluation of regional models of the transport and deposition of radioactive material due to accidental releases;

(d) Exchange of pollutants between the various environmental compartments (air, water, land) and integrated monitoring: the development of a long-term strategy for the active participation of WMO in co-ordinated international efforts towards Integrated Monitoring (IM) of the state of the environment and the implementation of the atmospheric component of IM, including the atmosphere/ocean/biosphere interaction; the improvement of the understanding of transfer processes and the natural cycle of chemical elements between the various compartments of the global atmosphere/ocean/biosphere system and the development of models to predict future states of the system from IM data; the further investigation of pollutant exchange between the atmosphere and the ocean as well as transport processes at the regional and global scales, the climate-related processes and features of the ocean micro-layer modified by pollutants, the role of marine-derived substances in the changing composition of the atmosphere; the improvement of capabilities to model and quantitatively assess these processes.

70. Arrangements for the procurement of equipment for BAPMoN and IM stations, maintenance services, spares parts, expert advisory services, training, data management and publication, and participation of selected categories of persons in technical meetings are provided with the principal assistance of UNEP while some of them receive additional support from some Members through WMO's Technical Co-operation Programme. These arrangements should be continued and intensified to achieve the objectives outlined in paragraph 69.

Applications of Meteorology Programme

71. The Applications of Meteorology Programme includes four components:

(a) Public Weather Services Programme;

(b) Agricultural Meteorology Programme;
72. The Public Weather Services Programme is a programme to improve the weather services to the general public including, in particular, improved warning services as a contribution to the International Decade for Natural Disaster Reduction (IDNDR). It is expected that technical co-operation projects will assist in the financing of this programme.

73. The purpose of the Agricultural Meteorology Programme is to assist Members to provide meteorological and related services to the agricultural community to help develop sustainable agricultural systems, increase production, reduce losses and risks, decrease costs, increase efficiency in the use of water, labour and energy, conserve natural resources and decrease pollution by agricultural chemicals. Although sometimes combined, climate information is used mainly for planning purposes, while recent weather data and weather forecasts are used mostly in current agricultural operations. Several technical co-operation projects in this field at national and regional level will provide part of the required funding.

74. The Aeronautical Meteorology Programme has the purpose of ensuring provision of the operational meteorological information required for safe, economic and efficient air navigation, and meteorological support to the non-real-time activities of the aviation industry. This programme is aimed at the global introduction of common standards in providing services on the basis of internationally agreed requirements stated by ICAO.

75. The purpose of the Marine Meteorology and Associated Oceanographic Activities Programme is the provision of marine meteorological and oceanographic services in support of the safety of life and property at sea and of the proper management of marine resources and the marine environment. The programme comprises the marine meteorological and physical oceanographic services provided by Members in support of maritime safety and basic economic ocean-related activities; a supporting composite operational global ocean observing system, together with an appropriate infrastructure for techniques development, information exchange, implementation support and education and training related to marine meteorology and physical oceanography. It will require substantial technical co-operation support to ensure the provision of the inputs needed by the programme.

76. The overall objectives of the Applications of Meteorology Programme are given in Part II, Volume 4 of the Third Long-term Plan.

Hydrology and Water Resources Programme

77. Through the 1970s and 1980s the Hydrology and Water Resources Programme developed into one of the major Programmes of WMO and now offers considerable assistance to countries in the task of meeting the increasing demands for the assessment and development of water resources, and protection from floods and droughts. A large amount of general guidance material has been published through the Commission for Hydrology and considerable progress has been made in the provision of more specific hydrological technology which
is available and appropriate for use in any specific circumstance. The Hydrological Operational Multipurpose System (HOMS), which aims at making hydrological technology available to any country needing help, has been very effective.

78. Valuable contributions are also being made by projects which catalogue and compare specific types of technology, such as instruments and catchment models.

79. Projects in hydrology and water resources represent a large proportion of the total of technical co-operation projects executed by WMO. They benefit directly from the information and expertise available through the Organization and the technical backstopping being provided by the Hydrology and Water Resources Department of the WMO Secretariat. The implementation of HOMS provides excellent scope for technical co-operation among developing countries (TCDC) in operational hydrology. The implementation of TCDC projects in this field depends on the willingness of Hydrological Services to make available the services of national experts qualified in the subjects concerned.

80. The main strategic objectives of technical co-operation in the field of hydrology may fall within any of the following five main categories.

(a) Establishment and/or strengthening of networks and services;
(b) Development of hydrological databanks;
(c) Hydrological forecasting;
(d) Training in hydrology;
(e) Support to WMO global or regional programmes.

As projects are tailored to the particular requirements of each country or group of countries, they frequently cover activities of more than one category. Moreover, many projects are devised to provide assistance to hydrological and meteorological activities at the same time. The financial and material support is provided by UNDP and other donor agencies and, increasingly, through WMO's own Voluntary Co-operation Programme.

81. The main thrust of technical co-operation will be to assist in the development of Members' Hydrological Services so that they are able to provide the information and forecasts needed by their countries for water resources development, conservation and management, for the mitigation of natural hazards of a hydrological nature and for the protection of the environment. To support this technical co-operation, HOMS can provide Members with modern hydrological technology in the form of HOMS components and sequences concerning almost the entire field of operational hydrology. These components and sequences are ideally suited for transfer through the VCP-HWR. It is planned to exploit this arrangement more effectively in the next four years.

82. Of the 109 UNDP-funded projects implemented by WMO during the period of SLTP, 25 pertained to hydrology alone and 22 combined meteorology and hydrology. Almost all these projects will be completed by the end of 1991 before the fifth UNDP programming cycle starts on 1 January 1992.
83. The period 1992-1995 is expected to see an intensification of WMO efforts especially in Africa where the national Hydrological Services urgently need external assistance in equipment and training and from experts to meet the increasing requirements for hydrological data and flood forecasting. However, it is very significant to note that in spite of the increase in disbursements from the international community (annual rate of growth of 16.9% globally) for water-resource assessment activities, the levels are much below what was estimated at the time of the UN Water Conference in 1977. The investment in water-resource assessment is estimated at only 2% of what is required. However, it is obvious that the ability of many governments of developing countries to increase their investment in the water sector cannot be expected to take place in the near future in view of the economic difficulties and structural adjustment programmes which they are going through. This is confirmed in the preliminary reports prepared under the World Bank/UNDP Sub-Saharan African Hydrological Assessment Project.

84. Specific recommendations and plans of action arising from this assessment should lead to projects in the field of operational hydrology in which WMO would be expected to play an important role.

85. A flood-control action plan has been adopted for Bangladesh wherein an expenditure of about US $24 million is proposed for the establishment of a nation-wide flood forecasting and early warning system. WMO has started the implementation of the first phase of this action plan and the activities are expected to reach a climax between 1992 and 1994.

86. These are but examples of specific WMO activities foreseen during the TLTP period. With the upsurge of concern about the global environment and climate, at both the scientific and the political level, and water being the most critical element, technical assistance in hydrology is expected to expand.

**Education and Training Programme**

87. It is foreseen that over the next decade, education and training activities will have to form an integral part of all WMO programmes to ensure that the national Meteorological and Hydrological Services of developing countries have the required well-trained personnel to carry out their functions and be able to adapt to new scientific developments and new technologies. In the long term, the Education and Training Programme will have the ultimate aim of developing, in the individual countries, self-reliant training capabilities which can then be complemented, as necessary, by regional training arrangements and institutions for higher levels of training, now viable or planned.

88. The overall objectives in education and training are given in Part II, Volume 6 of the Third Long-term Plan.
89. The Technical Co-operation Programme is structured, planned and implemented on a regional basis, taking into account the characteristics of the main funding sources:

United Nations Development Programme (UNDP)

90. The primary objective of UNDP is to support the efforts of the developing countries to accelerate their economic and social development by providing them with systematic and sustained assistance in the field of technical co-operation, geared to their national development plans and for the benefit of their entire population. In more specific terms, the assistance provided by UNDP is for the promotion of increasing self-reliance in the managerial, administrative, technical and research capabilities required for the formulation and implementation of economic and social development plans and policies in developing countries. To this end, UNDP is currently providing financial and technical support to numerous projects in agriculture, industry, education, power production, transport, communication, public administration, health, housing, trade and related fields.

The Country Programme

91. The UNDP Country Programme operates within a five-year framework called the programme cycle. The cycles of interest to the Long-term Plan cover the periods 1992-1996 and the following ones. Each Country Programme is prepared by the government of the country receiving UNDP assistance in collaboration with the Resident Representative and the Executing Agencies and indicates the proposed use of UNDP resources towards the achievement or furtherance of selected national development objectives during the period covered by the programme.

92. Country Programmes are approved by the Governing Council of UNDP. The approval of a Country Programme signifies the Governing Council's agreement to the application of UNDP resources towards the achievement of the development objectives indicated in the given programme.

93. The Indicative Planning Figure (IPF) gives the order of magnitude of the resources expected to be available from UNDP to the country during the five-year period. In some instances, additional resources may be available for a Country Programme, such as a cost-sharing contribution made by the government concerned or by a third party. Government cost-sharing means that the government shares with UNDP the costs of some project inputs that would normally be borne by UNDP.

The Inter-country Programme

94. In addition to the technical co-operation extended to individual countries under the Country Programme, UNDP is able to assist more than one country simultaneously under its Inter-country Programme. When two or more countries agree to participate in a single project of mutual interest, they may request assistance from UNDP. Such requests are forwarded to the Regional Bureaux at UNDP headquarters for their consideration and approval. Projects in this category include assistance to countries with common problems, such as mitigation of tropical cyclone damage, combating droughts and agricultural
development. While the Country Programmes reflect an individual country's priorities over which WMO has limited influence, the Inter-Country Programmes offer an opportunity for projects to be approved in the fields of activity which have priority within WMO.

Sectoral support

95. UNDP also allocates limited funds to smaller agencies such as WMO for sectoral support. The purpose of this support is to respond to requests from the Resident Representatives and the governments for short-term missions by consultants or Secretariat staff to provide advice and assistance with the formulation of projects or programmes and to assess existing services, identify needs and suggest improvements in services, staffing, facilities and organizational structure.

96. It seems also that UNDP plans in the near future to cease agency execution and implement all projects through government execution. Specialized agencies, such as WMO, will still play a role through scientific backstopping of projects. For this they will be reimbursed on a retainer basis. It is not clear how regional and global projects will be handled, but most likely the outcome will be a weakened support to WMO technical co-operation activities.

Technical Co-operation among Developing Countries (TCDC)

97. A special feature, introduced in recent years, is the support which UNDP provides to the efforts of developing countries to share their capacity and experiences with other developing countries, a concept referred to as TCDC. Under such a scheme, experts could be provided free of charge by one developing country to another and the UNDP contribution may be used to pay travel and per diem. Also equipment or spares, perhaps no longer needed in one country, could be donated to another developing country still using this type of equipment and UNDP might pay for the transportation and other related costs. TCDC arrangements are, however, not limited to these two examples and many innovative ideas can be worked out between the countries involved.

Voluntary Co-operation Programme (VCP)

98. Unique in the UN system, the Voluntary Co-operation Programme (VCP) is a highly successful WMO activity designed primarily to provide assistance in support of the implementation of the World Weather Watch. The VCP depends upon voluntary contributions from the Members of WMO to provide equipment, long- and short-term fellowships and short-term training such as seminars, equipment operation and maintenance courses, and on-the-job training conducted by seconded experts.

99. The VCP can be thought of as two sub-programmes which are:

(a) VCP national projects;
(b) VCP co-ordinated programmes.

100. By definition the co-ordinated programmes combine support from several donor sources and assist several recipient countries. The major problem facing the VCP is the inability of recipient countries to operate and maintain high-technology equipment in the current economic situation.
WMO Technical Assistance
All Sources

1952-1990

UNDP  VCP  Trust Funds  Regular Budget

WMO Technical Assistance
Voluntary Co-operation Programme

1971-1990

VCP
101. Management of the VCP is provided by the EC Panel of Experts on the VCP, which meets annually; VCP projects are approved for circulation to WMO Member countries by the EC panel or by the President of WMO acting on its behalf. The EC panel also authorizes the use of VCP(F) funds.

102. The introduction of VCP co-ordinated programmes provides an opportunity to focus VCP support on high-priority WMO requirements. Because of the regional nature of co-ordinated programmes, the WMO Secretariat plays more of a planning role in defining the requirements. This in turn allows for standardization of equipment, development of regional facilities, and co-ordinating support from several donors and between VCP and UNDP projects.

Trust-fund arrangements

103. Trust funds for financing and implementing technical co-operation activities may be in any of these three forms: (a) the donor country and the recipient country are one and the same, (b) a single donor country finances a project in another country or (c) a number of donors either bilaterally or multilaterally combine to provide co-ordinated assistance to one or more countries. WMO's role in (a) and (b) is largely one of administrative support and guidance for project execution, while for (c), WMO may be involved in project design and orientation, in co-ordinating donor inputs and in directing project activities. As an example, the AGRHYMET programme in the Sahelian countries is composed of a regional project and eight national projects financed annually by UNDP resources and complemented by trust funds from five donors and direct bilateral assistance from several countries. To the extent that donors and recipients agree, the requirements and priorities of the WMO programmes govern the allocation of available resources to technical co-operation projects.

Support from the regular budget

104. Funding from the regular budget is used for training in the form of fellowships and of seminars and workshops directly related to WMO's scientific and technical Programmes. Although not large in financial terms, it plays an important role as WMO determines the priorities and can help in filling the most urgent gaps in assistance being provided from other sources or where the needs are most critical. The regular budget also funds the management of the VCP office.
IMPLEMENTATION OF A STRATEGIC APPROACH

105. As noted, a strategic approach can be developed on the basis of two main sets of analyses: the Long-term Plan of WMO, which outlines the development of WMO co-ordinated programmes for the benefit of all countries, and the regional analyses of needs, carried out by regional associations and regional directors of WMO.

106. In the past these programmes and regional needs have been considered, informally, as a background for developing programmes in technical co-operation. This document is an attempt to ensure a more explicit synthesis and use of the requirement of the WMO programmes and regional needs, to undertake technical co-operation activities following agreed priorities.

107. The present means of supporting technical co-operation in meteorology and hydrology are detailed in paragraphs 90 to 104.

108. If we are to bridge the gap in a major measure through the means outlined above, then our strategies must:

   (a) Lead to more funds for technical co-operation in meteorology and hydrology;

   (b) Increase the benefits from technical co-operation expenditures.

109. To get more funding we must influence country planners in the developing world, officials of donor countries and officials of multilateral aid and funding agencies, all of whom are not meteorologists or hydrologists. This requires some major efforts on the part of WMO and Member countries, to make it entirely evident that investments in meteorology and hydrology can save lives, reduce property damage, improve major sectors of the economy, and provide major environmental and social benefits.

110. To be entirely convincing, WMO and the Member countries must back up educational and public relations efforts with some clearly defined programme needs and imaginative projects.

111. To get a bigger return for the funds provided, WMO (1) must ensure that as much funding as possible goes into meeting the highest-priority needs, (2) must ensure optimum co-ordination of efforts between projects, donors and national activities, and (3) must execute efficiently and cost-effectively those projects entrusted to the Organization.
STRATEGIES TO OVERCOME MAJOR IMPEDIMENTS IN THE IMPLEMENTATION OF BASIC LEVEL OF SERVICES

112. The main goal of WMO's Technical Co-operation Programme over the next decade should be to assist all countries to achieve at least the basic levels of meteorological and hydrological services outlined in the introduction to this volume. For those countries having already achieved such levels the main projects should be directed towards major improvements in applying such services to economic development, food security and safety of populations.

Major programmes and projects

113. The provision of basic services in meteorology and hydrology must be addressed at a national level. However, there are some common problems throughout several Regions and other problems that must be addressed on a regional or international scale that are essential to support national action. This section deals with these global or regional problems and with programmes and projects needed to address them, and then with national project needs. For each of the regional projects and for the major national projects a more detailed strategic plan must be developed to permit orderly and timely action by all concerned.

Regional

114. Communications networks in several Regions, especially Regions I, II and III, southern parts of Region IV and the south-eastern part of Region VI, are inadequate. The reception of SYNOP and TEMP data at Regional and World Meteorological Centres is regularly monitored. In October 1990, 42 per cent of SYNOP and 25 per cent of TEMP reports from RA I were received. The figures were 47 per cent and 17 per cent respectively for RA III. In all other Regions reception rates were from 41 to 88 per cent. The problems in Regions I and III are, of course, due in part to problems in implementing and maintaining observational programmes at individual stations, but lack of reception at World and Regional Centres is in significant measure a reflection of communication problems. Improvements are needed (a) to collect observational data in regional centres, (b) to transmit from one regional centre to another, (c) to communicate with centres in other Regions or continents, and (d) to disseminate weather information and products to users. Even where observational data are available they are frequently not used in real time because of communication problems. Very high priority must be attached in technical co-operation to solving these four interrelated communications problems. Unfortunately they cannot be adequately addressed by traditional country programmes and require VCF-co-ordinated regional projects (see paragraph 100) backed by major trust-fund, UNDP and World Bank funding.

115. A major objective of WMO technical co-operation, in order to bridge the gap in delivery of services, must be the establishment of well-equipped and staffed Regional Specialized Meteorological Centres in those Regions not now having them (e.g. RA I ACMAD and RA II/RA V ASEAN Centre). It is proving too costly in even the most developed Regions to have such centres in each country. Such centres, equipped with powerful computers, supported by good telecommunications facilities, and linked by the GTS to other specialized RSMCs and WMCs will produce short- and medium-range weather forecasting guidance and products for specialized services to agriculture and other segments of the economy. In some Regions RSMCs for tropical cyclone
forecasting are required. It must be emphasized, however, that the output of RSMCs must be designed to complement and support the work and output of the national Meteorological and Hydrological Services. Lack of reliable medium-range weather and hydrological forecasts for planning of economic activities, particularly for agriculture and water resources management, is especially evident in tropical regions. Extensive application of present medium-range forecasting techniques in developing countries should be a technical co-operation objective, along with establishment of institutions as part of the RSMCs to undertake research in developing regions to improve such techniques. It should also be emphasized that such centres could undertake the urgently needed studies of climate variability and change, with special emphasis on impacts in the specific region, such as sea-level rise or changes in rainfall patterns, which could have profound regional and global implications.

116. Such regional specialized centres can play a major role as well in retaining highly trained specialists within the Region by providing adequate facilities for research and operational challenges. They could reverse the meteorological brain drain from the developing countries.

117. It must be emphasized, however, that while the development and regular issuance of such meteorological products require the special facilities and staff that a regional specialized centre can achieve, the delivery of these products to users must be a function of the national Meteorological Services. Thus, of equal importance must be the strengthening of these Services to be able to interpret and disseminate the regional products in a way that achieves maximum benefit in each country.

118. To obtain funds for the three major regional centres WMO must undertake an aggressive search for donors. A commitment by Member countries is also needed. Finally, donors must be persuaded to support a parallel strengthening of national Services, especially in these three Regions, to ensure maximum use and timely delivery to users of the products that will be made possible by such centres. For Africa the International Centre for Operational Meteorology and Hydrology in Africa (ICOMHA) proposal of the World Bank has this balance and should be strongly supported.

119. The main natural disasters causing death and destruction—tropical cyclones (and other severe storms), floods and drought—are all hydrometeorological in character and at least somewhat predictable. In most cases predictions can lead to preventive measures to reduce loss of life and property. A few WMO technical co-operation projects have developed, with UNDRO, joint approaches to disaster preparedness, both to save lives and prevent damage in tropical cyclone areas, and through flood forecasts and flood plain mapping. More effort is required in all Regions to improve predictions of natural disasters and in the continued extension of WMO technical co-operation projects beyond prediction to include disaster preparedness and damage prevention strategies. The UN General Assembly has now designated the 1990s as the International Decade for Natural Disaster Reduction (IDNDR) and WMO must take steps with UN New York to ensure that it plays a central role in this programme. This should bring with it funding to increase technical co-operation projects to predict storms, floods and drought and co-operate with UNDRO in preventive measures.

120. The experience in the Sahelian area in the use of daily agrometeorological advisories to reduce crop loss and minimize costs of
fertilizers, pesticides, herbicides and labour in agricultural production must be extended to many other parts of Africa and regions of the world. This can probably best be done through establishment of additional regional centres of a similar nature to the AGRHYMET Centre in Niamey (e.g. sub-regional drought-monitoring centres - agrometeorological applications centres) supported by continental centres such as the ACMAD. To achieve such benefits the AGRHYMET Programme, Phases 3 and 4, must emphasize extension of daily advisories, by mass communication means, to most farmers in the CILSS region. At the same time funding for and establishment of drought-monitoring centres in eastern and southern Africa must be pursued. Drought-monitoring functions can be built into planning for other regional centres.

121. Boundary water issues between countries can be resolved only on the basis of authoritative and mutually agreed water data and analysis. WMO projects should increasingly emphasize trans-boundary water systems and the provision of data and forecasts as a necessary basis for the resolution of water disputes. To pursue this objective WMO must propose more hydrological projects in international basins and work closely with UNEP to support the first phase of UNEP's plan to develop basin management systems for seven international basins over the next few years.

122. The opportunity to train staff in specialized fields such as agrometeorology and energy meteorology is unavailable in certain countries due to lack of human resources and funds for fellowships and lecturers. All WMO projects in specialized fields should place strong emphasis on training components. Adequate support for existing Regional Meteorological Training Centres must be maintained by national contributors and donors, with an increasing role for such centres in provision of special training of particular importance in the sub-region concerned, on topics such as marine meteorology, hydrometeorology, and agricultural meteorology.

123. As transboundary air pollution and pollution of the global atmosphere in general become increasingly evident and potentially damaging, each country should have the capability to sample at least the atmospheric quality and the chemistry of precipitation. In the WMO system, this is being developed through the Global Atmosphere Watch (GAW) and its BAPMoN (Background Air Pollution Monitoring Network) stations operated in most countries. In most developing countries, this will require a technical co-operation project and some continuing assistance or co-operative arrangement for the laboratory analysis of samples. In developing countries potentially prone to damage from chemical or radioactive accidents or chronic pollution (essentially nearly all countries of the world), assistance will be required to model and predict mathematically the atmospheric transport, transformation and balance of pollutants. These environmental matters must receive increased emphasis in the WMO Technical Co-operation Programme in the next decade.

124. The need is great for assessment of water resources available for sustainable development in many countries. The WMO/UNESCO-developed methodology for undertaking such assessments should form the basis for a major drive to develop project plans and secure funding for national projects of water-resource assessment. The current World Bank-UNDP survey of Hydrological data and assessments in Africa should provide an independent estimate of needs in that Region.

125. Automation and computerization of routine tasks in meteorological and hydrological agencies is becoming cheaper and more reliable, with lower-priced
and better small computers. Software packages for such tasks as message switching in communication centres, and climatological data processing are now readily available and programmes for transfer of this technology such as SHARE (Software Help in Applications, Research and Education) and CLICOM must be further developed and strengthened.

National

126. Regular and specialized observational networks in many parts of Regions I and II and in some tropical areas of Regions III and IV are inadequate to meet minimum requirements. Networks must be extended and augmented. Weather satellite receiving capabilities are essential to augment point observations and where need and capabilities for maintenance exist, weather radars must be installed.

127. In meeting water needs for irrigation, domestic supply, power, industry and navigation, water data analyses are an essential underpinning. WMO technical co-operation projects must increasingly emphasize the applications of hydrological data as well as their collection and analysis. Such applications projects are needed in virtually all Regions and HOMS provides a sound basis for the exchange of scientific techniques which should be further promoted through all channels, including regional and national technical co-operation projects.

128. Yet another constraint is the lack of national databanks of climate data with established standards to ensure collection, quality control and accessibility of data. The archives should include summarized and derived data, including normals, extremes, frequencies and duration, and vigorous pursuit for completion in all developing countries of CLICOM and DARE projects is essential.

129. An ideal situation might seem to be one in which each Member has the capability of fully meeting its meteorological training needs. It would, however, not be cost-effective to establish facilities to run courses with small numbers of students or even with adequate numbers but infrequently. A network of national training facilities and programmes (for nationals and foreign students), and regional training centres must therefore be maintained. Thus, a desirable status will be one in which each Member meets its own Class IV training needs, and in addition meets its own training needs for the Class III, II and I levels where the numbers to be trained will make the establishment of relevant training facilities and programmes viable undertakings. Staff members of national Services must be trained more fully in the development and marketing of meteorological and hydrological products that will achieve optimum economic benefits.
130. It is planned that emphasis in technical co-operation programmes will be placed first on developing regional capabilities, secondly on developing the national Services identified in the regional analyses as requiring assistance to meet minimum levels of service and, thirdly, on exploiting regional and national capabilities to better serve agriculture and other economic sectors. All three categories will be pursued concurrently in some major projects and in the overall programme.

131. In a number of countries, especially in Regions II, III and IV, economies of developing countries have grown to the stage where UNDP projects require substantial national contributions, in some cases 80-100 per cent. In those countries, bilateral aid, assistance through trust funds from donor countries and VCP are assuming increasing importance. In these countries especially, but even in countries with potential for UNDP funding, WMO technical co-operation project proposals to be supported must be increasingly linked directly to a sector of the economy, e.g. agriculture, water management, energy, transportation, or to disaster-prevention activities. Unless the meteorological, climatological and hydrological projects are placed in their economic or life-saving context they are not likely to be supported by national planning departments. Much greater efforts to prepare projects with this perspective will be made by WMO.

132. A major impediment detrimental to the development and advancement of Meteorological Services is the low priority often accorded to most meteorological activities at the national level. In addition, many such Services were originally developed to support safety and economy in aviation. Hence about two-thirds of WMO Members do not provide adequate agrometeorological services, for example. In the case of Hydrological Services the situation is quite variable. In a few countries water issues are of such overwhelming importance that the agency undertaking hydrological work has a very high profile. However in general, even while water has a high economic and social importance, an awareness of the importance of technical hydrological activities is at far too low a level to obtain adequate programme support.

133. WMO in co-operation with national agency representations should develop a marketing approach to technical co-operation projects. This will require:

(a) "Market research" - greater effort to identify real national needs. Guidelines on techniques for undertaking such national studies will be prepared by the WMO Secretariat with suitable consultant assistance;

(b) Adaptation of the product to meet the identified needs;

(c) Efforts to ensure that national planners and donors are aware of the products designed to meet their needs;

(d) Better technical co-operation project design to take advantage of previous WMO and other agency experience and that of the country concerned (off-the-shelf projects such as HOMS, CLICOM and DARE can help this effort); and
Effective and efficient project execution through strengthened Secretariat efforts.

134. The Executive Council, at the request of its Panel of Experts on VCP, has fostered and supported the development of co-ordinated projects, whereby the Secretariat seeks to combine or co-ordinate resources from various sources (VCP, trust funds, UNDP, etc.) to undertake a much larger regional effort than otherwise possible. Examples include a new co-ordinated RTH system in South America, ANMET in the Caribbean, the DCP project as part of OWSE Africa, and SHARE. These efforts must be increased and adequate Secretariat support provided.

135. Strong action will be taken by WMO within the UN and donor-country system to encourage external funding of existing national Meteorological and Hydrological Services, and to ensure that activities in these fields supported in other national agencies are done in co-ordination and with the involvement of national Meteorological and Hydrological Services. As a first step WMO will write to donors of identified meteorological and hydrological projects undertaken through other national agencies to indicate the problems this causes and suggest that such activities be undertaken through or in co-ordination with the national Services in the field.

136. Since a major identified impediment to maintenance of adequate levels of services in many countries is the inability to obtain spare parts to maintain essential equipment, WMO will negotiate with UNDP for authority to permit use of local non-convertible currencies for this purpose. The high cost of expendables, e.g. radiosondes, continues to be a major problem for developing countries.

137. Technical Co-operation among Developing Countries (TCDC) has always been a strong feature of programmes in meteorology and hydrology, and appears to be increasing. WMO will document TCDC activities more fully, promote further use of TCDC, and seek maximum UNDP support for such activities.

Action required by developing countries for the implementation of the Technical Co-operation Programme

138. Each country seeking development assistance in meteorology and hydrology will be asked to prepare a medium-term (5- to 10-year) plan for meteorology and hydrology, based on the national priority needs, and on the basic levels of services outlined in this document. Shortfalls below basic service levels will have to be documented more fully by the countries themselves as a basis for input to national IPFs and for requests for technical co-operation projects.

139. It is strongly urged that each developing country should work with WMO to develop projects which clearly identify benefits to major economic sectors and are presented within the framework of those sectors.

140. There is a requirement for all countries, advanced and developing, to develop effective public information programmes informing planners and decision-makers of the benefits of meteorological, climatological and hydrological services. A meeting of public information officers of Meteorological and of Hydrological Services should be convened periodically by WMO to help ensure co-ordination and to discuss the specific messages to be conveyed and the best means of conveying them.
141. Where several agencies are involved in meteorology on the one hand or in hydrology on the other, countries should, wherever possible, designate and support one national Service in each field to direct or co-ordinate all governmental activities in each of these fields. It has been demonstrated in many cases that a Hydrometeorological Service combining meteorology and hydrology can have major advantages in managing data networks and in hydrological forecasting.

142. It is essential that the activities of Members in their manpower development be based on established plans for future roles, functions, staffing, and training of the national Meteorological, Hydrometeorological and Hydrological Services. The national manpower development plans should also be used to provide information for input into WMO programme planning so that assistance in the most deficient sectors can be provided.

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ANNEX

RESOLUTION 28 (Cg-XI) - THIRD LONG-TERM PLAN

THE CONGRESS,

NOTING:

(1) Resolution 25 (Cg-X), under which Tenth Congress approved the Second Long-term Plan,

(2) The decision of Tenth Congress in Resolution 26 (Cg-X) concerning the preparation of the Third Long-term Plan,

ADOPTS, under the provisions of Article 8 (a), (b) and (c) of the WMO Convention, the Third WMO Long-term Plan (hereinafter called "the Plan" for the period 1992-2001, consisting of:

Part I - Overall policy and strategy

Part II - Programme plans

Volume 1 - The World Weather Watch Programme;
Volume 2 - The World Climate Programme;
Volume 3 - The WMO Atmospheric Research and Environment Programme;
Volume 4 - The WMO Applications of Meteorology Programme;
Volume 5 - The WMO Hydrology and Water Resources Programme;
Volume 6 - The WMO Education and Training Programme;
Volume 7 - The WMO Technical Co-operation Programme;

REQUESTS the Secretary-General to arrange for the publication and distribution to all Members and constituent bodies of WMO - and to other international organizations as appropriate - of Part I and its Executive Summary, and Part II of the Plan;

URGES Members to take the Plan into account in developing and carrying out their national programmes in meteorology and operational hydrology, as well as in their participation in the programmes of the Organization;

REQUESTS the Executive Council, the regional associations, the technical commissions and the Secretary-General to adhere to the policies and strategies set forth in the Plan and to organize their activities to achieve the main long-term objectives as defined in the Plan;

FURTHER REQUESTS the Executive Council to use the Plan as a benchmark to monitor progress and performance in the implementation of the scientific and technical programmes of the Organization and to submit a report to Twelfth Congress.