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Hanson-Cooke

African Weather and Water Data Exchange

It is commonly known that forecasts of weather, floods, natural disasters, El Niño, and climate change affect almost every aspect of human existence and activity. Telecommunications is the means for collecting and exchanging data required for forecasts nationally and internationally. Naginder Sehmi discusses the issue in the African context.*

Keywords: weather, data, disasters, forecasts, satellite, privatisation.

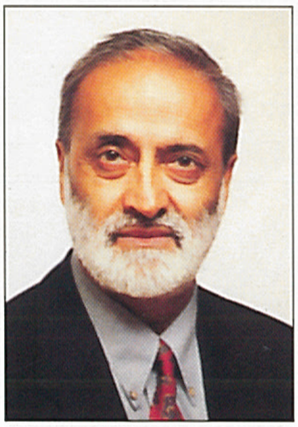
Is economic growth supported by advanced technologies, in particular telecommunications, transforming African societies in the same way as those elsewhere? The communications revolution is mostly presented as good news for developing countries who hope that it will visibly increase productivity. The combined force of Internet and wireless, added to rapidly modernising telecommunication networks, has created an opportunity to leap several technological stages and bring these countries up to rich-world standards. This might be true for many Asian countries but can it be said of the sub-Saharan Africa? Some major developmental shortcomings are hindering many African countries, South Africa excepted, from sharing in the telecommunication revolution, except perhaps in the domain of data-carrying networks. One such existing network which might profit is the African segment of the Global Telecommunication System (GTS) of the World Meteorological Organisation (WMO) used for collection and exchange of weather and water data nationally and internationally (see Box 1).

WORLD WEATHER WATCH

WWW in the Service of Disaster Mitigation

Other than routine public weather forecast broadcasts on radio and television, there are the less commonly known prompt and accurate meteorological services tailored to aviation, shipping, transport on land and inland waters, air pollution monitoring and research, climate change studies, ozone layer depletion surveillance and above all, to mitigation of damage caused by natural and accidental disasters (Figure 1).

Natural disasters tend to occur at random in time and space. Existence of a network of strategically located observing stations coupled with a telecommunication system in the vulnerable areas is the only way of forecasting, monitoring, and issuing warnings required by disaster relief agencies and the public in order to mitigate loss of life and property. Disasters may be caused by severe tropical cyclones in the shape of typhoons and hurricanes, floods, droughts, tornadoes and severe thunderstorms, storm surges, snowstorms, extremely high or low temperature spells, landslides, avalanches, forest fires, and earthquakes. In short, it would be difficult to safeguard people without telecommunication facilities earmarked for observing these phenomena.



Mr. Naginder Sehmi, a senior scientific officer (retired) of the WMO, was responsible for the implementation of field projects related to monitoring and assessment of water resources and river flow forecasting requiring weather services, forecasts and data. He started as a hydrologist with the Kenya government and, in 1969, became the co-manager of Hydrometeorological Survey of the upper Nile basin. Since then he has served WMO for 27 years on a variety of issues including organising the African Conference on Water Resources: Policy and Assessment (March, 1995).

Mr. Sehmi has a Master's degree in geography and history from Trinity College, Dublin University, Ireland, and a postgraduate diploma in hydrology from Prague, Czech Republic.

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Weather Data Exchange

Data from all over the world are needed to provide weather forecasts. Without efficient telecommunications, this vital service cannot operate. Meteorological data are collected in real time from observation stations in each country which cover many not easily accessible parts. Each national centre processes the observed data and puts it on the GTS. The GTS circuits (see Figure 2) are composed of a combination of terrestrial and satellite telecommunication links. Each day, high-speed links transmit over 15 million data characters (alphanumeric and binary) and 2000 weather charts through three World, 35 Regional and 183 National Meteorological Centres at a speed, automation and efficiency not thought possible when WWW was conceived in the 1960s. All centres cooperate with each other in preparing weather analyses and forecasts in an elaborately engineered fashion. It is through WMO that the complex agreements on standards, codes, measurements and communications are established internationally.

If there were no WMO, the nations of the world would have to conclude individual agreements with one another to ensure the exchange and availability of data to meet the national requirements of economically vital sectors such as agriculture and utilities (gas, electric power production). An aircraft does not take off, nor does a ship leave port, without a weather forecast. Provision of such services is part of the international responsibilities of individual countries which would be hard pressed to provide accurate and timely information if the global infrastructure established under the auspices of WMO did not exist.

*The views expressed herein are those of the author and are not intended to reflect the views of the WMO or any officials or delegations therein.

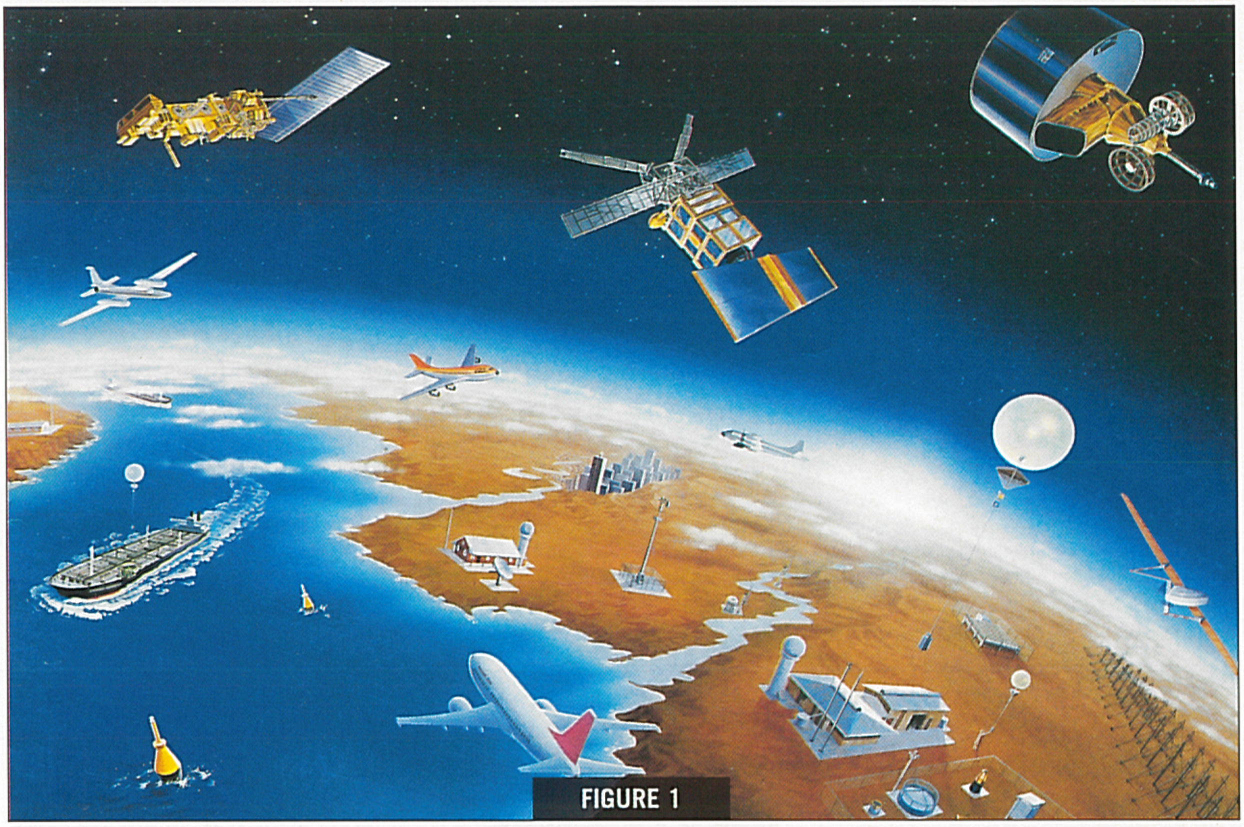

FIGURE 1

Observing the weather and climate. This artist's impression shows the main meteorological observing systems which underpin the operation of the WMO World Weather Watch in the 1990s and which will provide the foundation for the Global Climate Observing System in the 21st Century. (Courtesy WMO and Australian Bureau of Meteorology)

How the GTS Functions

The GTS comprises point-to-point circuits, point-to-multi-point circuits for data distribution, multi-point-to-point circuits for data collection, as well as two-way multi-point circuits. It is organised on three levels:

- The Main (global) Telecommunication Network linking together three World Meteorological Centres (Melbourne, Moscow and Washington) and 15 Regional Telecommunication Hubs (Algiers, Beijing, Bracknell, Brasilia, Buenos Aires, Cairo, Dakar, Jeddah, Nairobi, New Delhi, Offenbach, Toulouse, Prague, Sofia and Tokyo) responsible for collecting and relaying global traffic;
- The Regional Meteorological Telecommunication networks interconnect the National Meteorological Telecommunication Centres and the Regional Telecommunication Hubs within each of the seven WMO Regions (Africa, Asia, South America, North-Central America, South-West Pacific, Europe and Antarctica) and carry observed data and processed information;
- The National Meteorological Telecommunication networks collect observed data and distribute meteorological information to meet national requirements.

The overall responsibility for coordinating the GTS is with the WMO Commission for Basic Systems which is composed of representatives from most of the National Meteorological Services of the World. According to the agreed rules and regulations, each country has the responsibility of implementing, operating and maintaining the GTS circuits and facilities assigned to it.

THE PROBLEM

Weather Data

The overall usefulness of the GTS diminishes if countries are unable to collect national data required by the world community. While the demand for data has increased manifold, production of data in many African countries has not improved during the last ten years (see Table 1). Economic reasons make it difficult for African governments to fulfil their international commitment. They are even more hard pressed within the country because socio-economic issues have a higher and more immediate priority than scientific and technical ones. In many African countries the meteorological agency cannot adequately meet the urgent needs of their own users mainly because of weak telecommunication networks.

According to the 1997-monitoring of the WWW systems there are 1060 synoptic weather stations in Africa. Of these, 621 are required in the regional basic synoptic network, and should make 8 observations per day and their reports should be exchanged regionally, with 4 observations per day exchanged globally. Only 353 stations are reported to be making the full observation programme and 29 stations have stopped reporting. The rest are in between. Although relatively cheap and reliable technology is available, it is becoming increasingly difficult to maintain the national data collection systems of Africa.

The survey has also shown that the Regional Meteorological Telecommunication network of Africa also has operational and implementation shortcomings. This network, which consists of circuits interconnecting meteorological centres using different means of telecommunication, still includes a significant number of unreliable low-speed circuits (see Figure 3).

Water and Climate Data

The coverage of the weather observing network usually cannot meet the requirements of a number of other economically and socially important national activities, in particular for purposes of monitoring water resources, quality of air and freshwater, irrigation, and the environment in general. National institutions responsible for activities in these fields often have an even bigger technical data collection network in the country than that for weather. Table 2 shows the size of water resources monitoring networks in

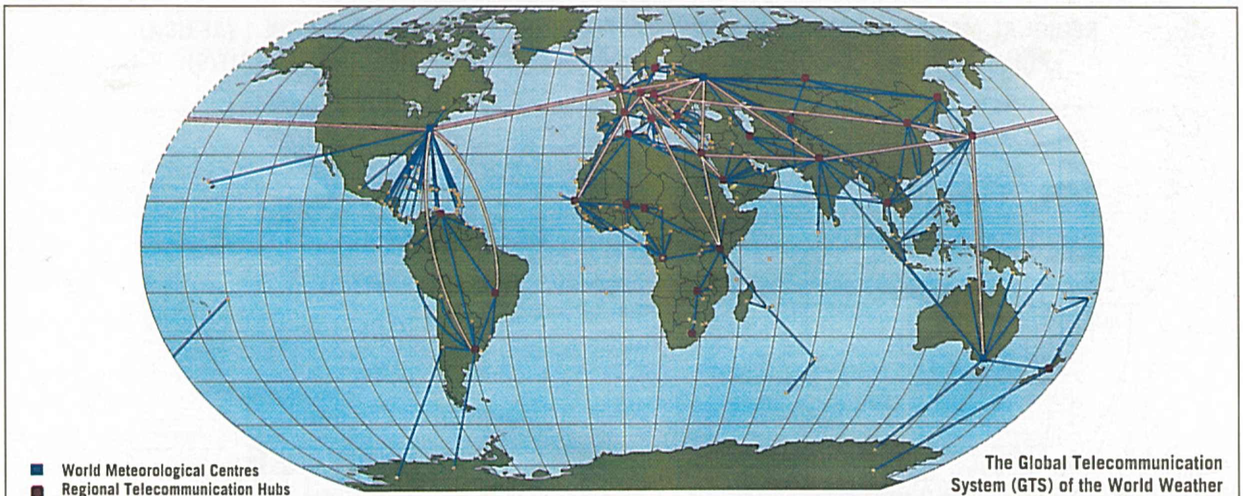

FIGURE 2 The Global Telecommunication System (GTS) of the World Weather Watch. The GTS enables rapid and reliable collection, exchange and distribution of meteorological and related observational data, analyses, forecasts and warnings between the national Meteorological Services of WMO Members (courtesy WMO).

35 out of 52 countries in Africa. Extrapolating these figures to cover the whole of Africa would give 75 000 stations requiring 170 000 transmissions a day if the system is to be operated to meet only the current basic national needs.

In addition to the synoptic weather stations described earlier, Africa (excluding South Africa) has more than 570 climatological stations observing multiple parameters. Add to this networks for drinking-water quality and the environment and it will amount to a need for telecommunications for transmitting over 2.5 million data characters – an attractive complementary business for relatively small enterprising firms in each country.

New Requirements

The GTS is facing new requirements for exchanging larger volumes of data, and products that are required by the national meteorological and hydrological services. Strengthening of the telecommunication infrastructure is therefore fundamental. Since the early eighties, the GTS development has been based on the Open System Interconnections (OSI), especially the ITU recommendation X.25. However, the strategy for the future is to introduce TCP/IP protocols as used on the Internet to replace X.25. This change in the GTS strategy stems from the reduced vendor support for X.25 technology and increased costs compared to TCP/IP which can support numerous off-the-shelf application utilities for information transfer in a more flexible and versatile manner. The changeover should permit countries to make considerable savings in financial and human resources and reductions in cost of purchase and maintenance of equipment and in software development, because industry standard software is freely available. Even the small national meteorological services should now be able to afford the latest technology.

The main problem, or the missing link, other than shortage of funds, is the lack of know-how to put together simple, practical operational solutions. Frequently it is the lack of initiative to use very cheap software (which can meet most of the national needs). Naturally, big companies are not happy with such initiatives because they would like to sell big complex systems.

TELECOMMUNICATION MARKET IN WEATHER AND WATER DATA

Current Situation

African telecommunication services are unable to expand their telephone facilities to meet the increasing local demand because they have problems of generating adequate funds for investment. The biggest money-spinner is still carrying voice calls. In order to raise funds, government-owned (or backed)

STATUS OF WEATHER DATA COLLECTION AND EXCHANGE (1997)
(Source: WMO)

REGION	No. of reports required	% expected	% received
Africa	2484	84	45
Asia	4752	96	81
South America	1744	78	48
N & Central America	2328	90	71
SW Pacific	1624	63	51
Europe	2728	98	90
TOTAL	15660	88	69

TABLE 1

SIZE OF NETWORK OF HYDROLOGICAL OBSERVING STATION IN 35 AFRICAN COUNTRIES (1987) (Source: WMO)

Type	Number of stations	Number of transmissions per day*
Rainfall: Non-recording	16349	32698
Recording	2452	14712
Evaporation	1234	2468
River flow: Recording	3242	19452
Non-recording	6108	12216
Water level: Recording	1534	9204
Non-recording	3657	7314
Water quality	907	907
Groundwater level	14978	14978
TOTAL	50461	113949

*Non-interrogated

TABLE 2

REGIONAL METEOROLOGICAL TELECOMMUNICATIONS NETWORK FOR REGION 1 (AFRICA)
POINT TO POINT CIRCUITS IMPLEMENTATION (TRANSMISSION SPEED IN BIT/S)

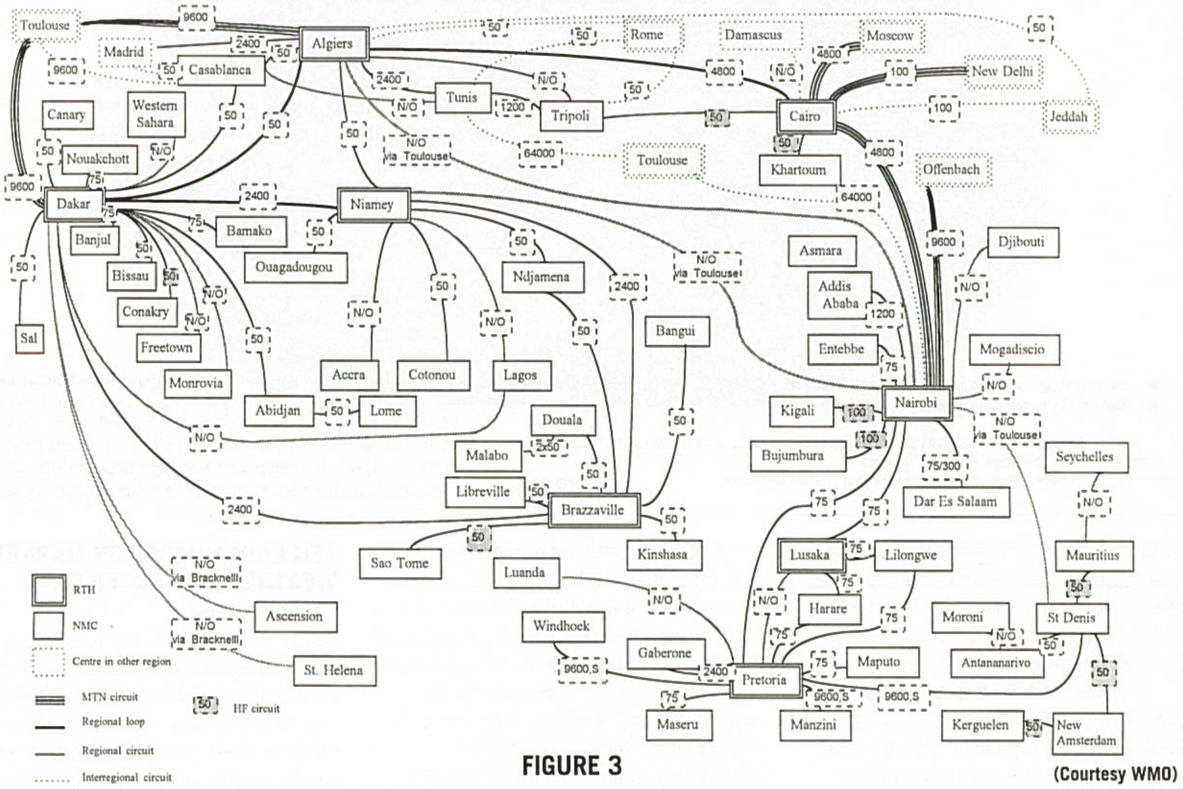

FIGURE 3 **(Courtesy WMO)**

monopolies usually impose highly propped up prices on long-distance and international calls. However, unlike in many other countries, they have so far failed to produce profits from this source. Africa's share, in 1995, of the total global international telecommunication traffic by origin is only 2.1 per cent.

In Africa, population is still so scattered that it will take a good two decades before urbanisation will start to reach the European and Asian level and benefit from economies of scale. The pace of economic growth has been slowing down compared with most other parts of the world. Therefore, the profitable voice-carrying telecommunication market and investment in it will grow rather slowly. Moreover, African countries suffer from some serious developmental shortcomings because they cannot:

- Afford access to new operational technology, sophisticated telecommunication systems and infrastructure;
- Build, operate, manage, and service the complex systems;
- Manufacture their telecommunication equipment and have their own telecommunication satellite.

That the whole of Africa has fewer telephones than Tokyo is an indicator of the relatively slow rate of development and smallness of the market. At the end of 1994, there were just over 291 000 cellular users in Africa. The number is forecast to increase to about 1.7 million by the end of 1999. Of this, 82% are expected to be in just three countries: South Africa, Egypt and Nigeria. While the market for telecommunication is concentrated in the cities, much of the wealth comes from rural areas. Studies have shown that telephone expansion into economically productive areas can generate an increase in GDP of 3.5% there.

There is no doubt that banks, stock markets, railways, electricity companies, institutions that provide weather forecast services, managers of water resources, and often those responsible for natural disasters and epidemics need cheap and easy access to efficient telecommunications for real-time data exchange. Collection of weather and water data is almost entirely a government activity not yet touched by local market pulls.

Investment Prospects in Data Exchange

It seems that not all these obstacles to the overall development of telecommunications in Africa apply to the rapidly expanding, pipe-filling, data and information exchange. One important difference between voice and data telephony is that the major demand for data on Africa is in Europe, North America and Asia where a deluge of demand has been accompanied by the spread of computers and Internet. In Europe, the present total traffic of 80% voice and 20% data is expected to reverse in the next six years. By the end of the century 20 to 30% of mobile revenue is expected to come from data services. There seems to be good small-scale commercial prospects for using the revolutionary technology, so popular for voice-telephony, to improve collection and transmission of data from Africa to feed national and external demand.

Large volumes of non-real-time data are already being exchanged through Internet/email facilities which constitute a major thrust for improving telecommunication infrastructure even for collection and exchange of data in real time. Although still slow, Internet is very cost-effective for the end user. Telecommunication companies which lease circuits to Internet access providers are actively promoting the expansion and improvement of Internet because it is a promising source of new types of customer and profit.

Hope Lies in New Technology

In Africa, institutions responsible for weather forecasting and monitoring of water resources usually do not have financial resources to set up much needed new types of telecommunication systems or to maintain and operate the existing ones. The telecommunication authorities find it uneconomical to provide landlines, put up radio antennae, or even to link up with satellites to cover rural and

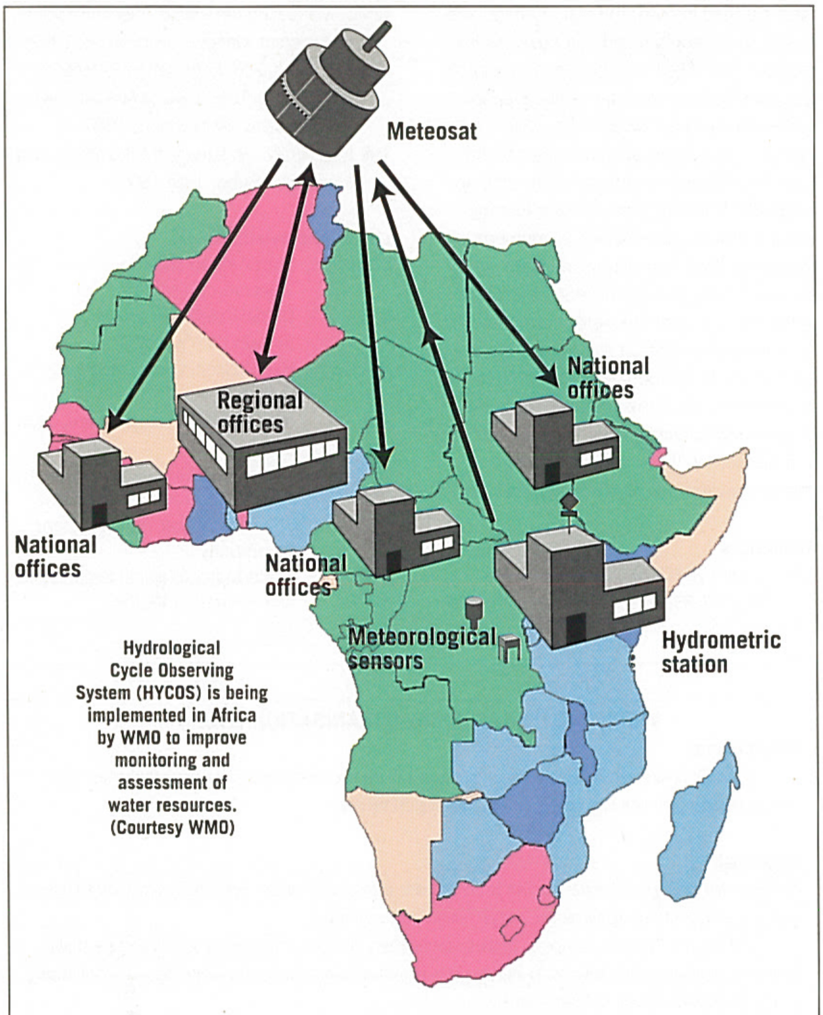

FIGURE 4

remote uninhabited regions which are often inaccessible (forested, arid or mountainous) and where weather and water resources must be observed continuously. Salvation seems to lie in the easily available new technology in association with privatisation.

Satellite-based mobile phones have revolutionised telecommunications in the last five years. Cellular telephones, which are still a businessman's luxury in Africa, have the best prospect of reaching the remote and scattered markets because the wireless system obviates expensive landlines. The mobile phone can quickly become the poor person's communication device.

While the cellular system might be appropriate for collecting weather and water data near well-populated areas, satellite-based systems would be a cheaper and more appropriate alternative for extra-urban areas. The gap between the price of fixed and mobile is shrinking fast. Therefore, the application of mobile phone technology to weather and water data collection cannot be ignored, especially in Africa where the observation stations are usually manned. An automated unmanned station is subject to vandalism. A customised mobile phone would enable the observer to easily transmit the readings as a digital input to the central computer.

Satellite-based Telemetry: Existing and Planned

Besides data collection systems operated via geostationary or near-polar orbiting meteorological/environmental satellites dedicated to weather data (e.g. ARGOS and METEOSAT), telecommunication satellites, through such services as RETIM or FAX-E via EUTELSAT, are efficiently complementing the point-to-point GTS circuits. Several countries, including Argentina, Canada, China, France, India, Indonesia, Mexico, Saudi Arabia, Thailand and the USA, are operating satellite-based multi-point telecommunication systems for their national meteorological telecommunication networks.

Use of satellite-based telemetry is making much headway in Africa in other ways. For example, a project funded by the European Union is setting up a Hydrological Cycle Observing System (HYCOS) for the Southern African Development Community (SADC), consisting of:

- A data collection system with data collection platforms installed at 25 key river stations equipped with 15 sensors for measuring water level, Ph, conductivity, temperature, dissolved oxygen, turbidity as well as air temperature, rainfall, relative humidity, wind-speed, and net radiation, besides four sensors for housekeeping;
- A data transmission and reception system using METEOSAT;
- A regional database in the SADC Regional Centre for Water Resources (Lesotho);
- An inter-connected computer network between the national databases of participating countries and the regional centre.

While more satellite-based telecommunication facilities, such as the low-Earth orbiting satellite (LEOs) systems, will cater for collection and exchange of data, a number of private initiatives have also sprung recently.

Thuraya Satellite Communications, a private company based in the United Arab Emirates, is planning to launch a large mobile satellite service in May 2000, which will cover Latin America, the Middle East, eastern Europe, Indian sub-continent and many parts of Africa for transmission of voice, facsimile and data. The Thuraya service will target not only business customers but also those who want to extend the coverage of their current terrestrial service, particularly for weather and water data collection. In addition to a number of other similar ventures, the African telecommunications operator, Raduga, is said to be planning to launch a mobile satellite service over the whole of the African continent. A new company – Euro African Satellite Telecommunications (EAST) is designed to include data services for remote regions at competitive prices.

COMPETITION CAN BE THE MOTOR

In 1994, South Africa accounted for almost 80% of all cellular subscribers on the continent. Penetration of cellular systems in the rest of the continent is gradually picking up speed. In a majority of countries in Africa, telecommunication service is still a state monopoly. But, increasingly, these services are being transferred to public corporations with financing that is independent of the main government budget. The increasing trend for privatisation and deregulation, largely encouraged by external bodies, is presenting new opportunities for foreign investment. This provides attractive opportunities for the establishment of joint ventures with foreign investors and operators. By the end of 1999, most countries in Africa will have operational cellular networks, in some form, spreading gradually from the cities into the countryside.

If governments would be willing to encourage the private sector to participate in developing telecommunications related to technical services, a developmental revolution can be started. Private companies would be interested in bringing in new ideas and ways of doing things which are compatible with African conditions. Technical services can rent spare capacity on networks from these companies, in addition to continuing to use government-backed monopolies. Competition should lead to cheap and easy access to telecommunication satellites. Experience in other countries has shown that privatisation has also benefited existing monopolies, because they control connections to the national network.

Privatisation is not, however, widely popular in Africa, although it is well-known that private management usually succeeds in squeezing costs and improving quality of service in even the best-run state-owned businesses. Foreign multinationals see privatisation as a way into Africa, enabling them to install themselves in alliance with local firms. This process can be initiated only by liberalising telecommunications licensing. African countries will have to concord with the changes taking place in the European Union, where full competition has been allowed in this very dynamic sector from the beginning of 1998.

THE APPROACH

The conditions in Africa being similar to those in South America, the experience in Chile is relevant. Government should set up a fund with a short (say four-year) life, offering a subsidy to any company willing to provide specialised users, such as the weather and water resources agencies, with telecommunication services. In Chile, the bids that this offer attracted have so far allowed half the rural and remote areas to be served without any subsidy at all. Private investment amounted to 20 times what the government had spent. The average cost of 1285 rural public phones was $1643 a station. Compare this with pre-competition times when the average cost of 300 stations was $20 000 a piece. Interestingly, the Regional Meteorological Telecommunication Network for North-Central America, now uses a satellite-based commercial telecommunication facility.

In this respect, one has to critically evaluate projects such as the SADC – HYCOS, because the water and weather data collection system being installed is not effectively integrated in the existing telecommunication system nor in the government structures. There is little participation of the private sector. If SADC – HYCOS and other similar projects planned to cover the rest of Africa (see Figure 4) are not handled in a business-like manner, their fate in the long term would be as precarious as that of the ARGOS-based system in the Niger River Basin, which is rapidly shrinking because countries do not have the means to maintain it. Similarly, an automatic telemetry system using existing telephone lines was installed in southern Malawi for flood forecasting and warning. Increased load and insufficient maintenance of the lines brought the system to a standstill. One noticeable effect of financing agencies such as the World Bank has been that most governments are realising that the required funding and operating expertise for infrastructure development can only be obtained through privatisation or joint ventures.

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List of Abbreviations

EAST	Euro African Satellite Telecommunications
GTS	Global Telecommunication System (WWW/WMO)
HYCOS	Hydrological Cycle Observing System
ITU	International Telecommunication Union
LEOs	Low-Earth orbiting satellite systems,
OSI	Open System Interconnections
SADC	Southern African Development Community
WMO	World Meteorological Organisation
WWW	World Weather Watch

WORLD METEOROLOGICAL ORGANISATION (WMO)

Membership

As of June 1996, there were 185 members, comprising 179 member states and six member territories, all of which maintain their own meteorological and hydrological services.

Organisation

The World Meteorological Congress, which is the supreme body of WMO, meets every four years. It determines policies, approves the programme and budget, and adopts regulations.

The Executive Council is composed of thirty-six members. It meets at least every year to prepare studies and recommendations for Congress, to supervise the implementation of Congress resolutions and regulations, and to advise Members on technical matters.

Members are grouped in six regional associations (Africa, Asia, South America, North and Central America, South-West Pacific and Europe). Each of them meets every four years to coordinate meteorological and operational hydrological activities within their region and to examine questions referred to them by the council.

WMO has eight technical commissions, responsible for: aeronautical meteorology; agricultural meteorology; atmospheric sciences; basic systems; climatology; hydrology; instruments and methods of observation; and marine meteorology. Each of them meets every four years.

Major Programmes

World Weather Watch, World Climate Research Programme, World Climate Programme, Atmospheric Research and Environment Programme, Applications of Meteorology Programme, Hydrology and Water Resources Programme, Education and Training Programme, Technical Cooperation Programme. Overall, WMO's activities contribute to the safety of life and property, the socio-economic development of nations and the protection of the environment.

Funding

Member States contribute according to a scale. The maximum approved expenditure for the financial period 1996-1999 is Swiss francs 255 million. The extra-budgetary contributions amount to Swiss francs 89.7 million.

The Secretariat

The staff post ceiling is 246. The Secretary-General is Professor G. O. P. Obasi (Nigeria).

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