Strengthening Operational Agrometeorological Services: Needs from Agriculture Sector

Current and Potential Functions of National Agrometeorological Services: The Agricultural Demand Side

Istiqlal Amien
Agroclimate and Hydrology Research Institute
Bogor, Indonesia

Abstract

Agriculture, providing basic needs and services and one of the biggest employers, is one of the most weather-dependent industries. A crucial role of the National Meteorological Service (NMS) is timely provision of accurate information on agrometeorology. With few NMSs under the agriculture portfolio, priorities rarely focus on serving agriculture. Even those with observation networks do not always provide services, often due to the shortcoming in their analytical capability. Along with staff and budget constraints, the service suffers from a poor understanding of the diverse agricultural users and their requirements.

Information requirements vary with different farming practices, while research and education require more detailed information with different emphasis. Among the variables with strong effects on crop growth and farm management are daily temperature, precipitation, solar radiation, and wind speed. More general information is required in advance by agricultural policymakers, planners, and institutional support systems for better planning. With challenges in climate change, desertification, and biodiversity, many NMSs can play a crucial role in improving understanding and finding ways to mitigate and adapt. The NMS can take advantage of advances in computer and communication technology to improve analytical capability and service delivery.

With limited resources available, an effective way to benefit from the progress is through cooperation among countries within a region. By putting together the best resources and expertise, the limited resources can be more efficiently utilized. Presently, many climate institutions provide near real-time global observations of the ocean and atmosphere and periodically post the analytical results of their implications on regional climate. NMS can take advantage of the information by calibrating the results in the region for local use and by providing feed back for the improvement of the service.

Introduction

As the largest employer in the world, involving about 49 percent of the world's work force (60 percent in developing countries), a healthy agricultural sector is a prerequisite for sustained economic growth in most countries. Adequate supplies of affordable food are essential for poverty alleviation and economic development. As one of the most weather dependent of all human activities, variations in weather and climate, as well as their interaction with agricultural operations from planting to harvesting, determine appreciable parts of the yield variations. Despite the advances made in our understanding of the influence of climate on agricultural production, climate variability will continue to be the principal source of fluctuations in global food production.

Advances in the transportation systems and refrigeration technologies have substantially reduced the cost of transporting goods and allows agricultural producers to reach further markets. Along with the growing regional cooperation, agricultural trade among countries has become more common. The ongoing change requires good agrometeorological information for the envisioned sustainable agriculture that not only requires sound technology, but must also be economically feasible and socially acceptable.

The growing interest on the potential impact of natural- and human-induced climate variability and long-term climate change on agriculture and forestry requires agrometeorological information and assessments. The growing demand for food and concern about the need to achieve greater efficiency in the use of natural resources while conserving the environment is placing a much greater emphasis on understanding climatic resources. The need for reorienting and recasting meteorological information, fine tuning of climatic analysis, presentation in forms suitable for agricultural decision making, and insulation of marginal farmers from the adverse impacts of weather vagaries has become more pressing.

Data are the fundamental basis for the provision operational agrometeorological services. However, it is the informational products that are the framework for any knowledge-based decision process. The ability to integrate the information from interdisciplinary sources utilizing new computer-based technologies and telecommunications creates a great opportunity to enhance the role of agrometeorologists in many decision-making processes. Information may be in the form of advisories regarding planting or spraying decisions to be used by extension services for the agricultural community. It may also be incorporated into early warning alerts related to food security or market implications. Early warning information allows improved long-term planning that will benefit agriculture.

Beyond daily and seasonal farm-management decisions, agrometeorological information can also play a valuable part in risk management. The information can be used with new technological tools and data base infrastructures to assess risk and to quantify probabilities associated with the variability. The implications are enormous not only for agricultural extension services but also for policy level decision makers who are responsible for food security and marketing decisions for agricultural products.

Current Functions of National Agrometeorological Service (NAS)

According to a survey conducted by World Meteorological Organization (WMO) among its members in 2003, agriculture along with disaster management, were the second largest applications of meteorological services after aviation. Environmental protection and mass-media come third and fourth, respectively. Agriculture is perceived as the most important user equal with aviation in Asia and exceeding it in South America. In the least developed countries (LDC) and countries in transition (CIT), agriculture is equally as important as aviation. In the developing and developed countries, disaster management was ranked the second highest application. The importance assigned to aviation probably because most of the NMSs (52.9 percent) fall under the Ministries of Transportation and Communication. Only 9.1 percent of the services come under agriculture, mainly in Asia, America, and Europe. The other NMSs are under Environment, Science, Defense, and others; including Water and Natural Resources, Public Works, and Energy portfolios.

Overall national funding, modernization, capacity building, and the definition of the role of the services at the national level are listed as the most pressing issues facing NMSs. Of the 103 services that responded to the questionnaire on budget, it ranged from US$7 million for LDC to US$135.9 for developed countries. The average NMS annual budgets per capita are 0.27; 0.75; 1.59, and 3.48 US$, for LDC, CIT, developing countries and developed countries, respectively. Region-wise, the highest is in North America with 3.12 US$ per capita, followed by South West Pacific 2.44 US$, Europe 1.95 US$, Asia 0.95 US$, Africa 0.71 US$, and South America 0.32 US$. These budgets are about as much or less than one-day cost of living for the poorest in each region. The low budget has caused the services to try and improve their income through cost recovery for specialized services. This is another reason why aviation is the main customer of many NMSs, as they pay for the services.

Of 181, 481 NMS total staff in 120 countries that responded to questionnaire on personnel, 44 percent were professional, 46 percent were technicians, and 10 percent were in administration. A closer look reveals that the share of professionals is far lower in the less developed countries whereas 16.3; 18.6; 23.9 percent, respectively for Africa, South America, and Southwest Pacific compared to 47.9; 59.1; 53.0 percent for Asia, America, and Europe. Based on the stage of development, the professionals are 25.6 percent in LDC, 38.7 percent in developing countries, 45.7 percent in CIT, and 53.5 percent in developed countries.

The relative importance of technicians indicates the opposite trend with the highest percentage of 60.2 percent occurs in LDC, followed by 50.8 percent in developing countries, 46.6 percent in CIT, and 38.6 percent in developed countries. This is reflected by the educational level of the NMS staff, where a high proportion of high school levels compare to those with bachelor or higher degrees in regions like Africa and Southwest Pacific or in less-developed and developing countries (Figure 1).

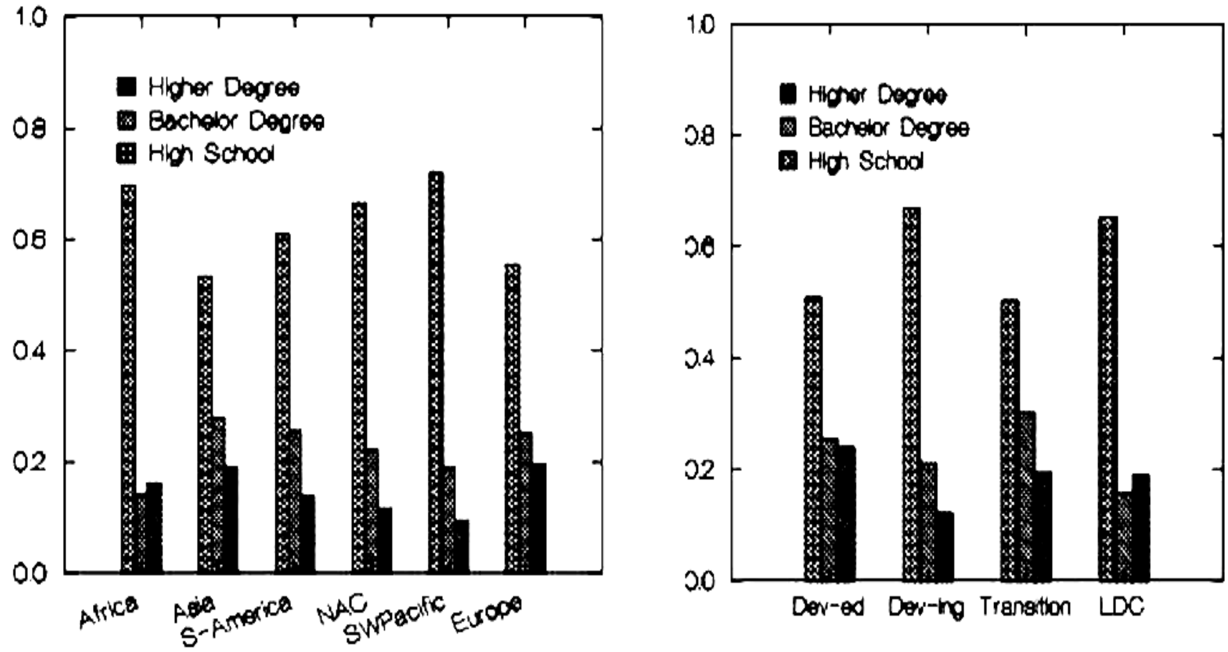

Figure 1. Proportion in the level of education of the personnel of the meteorological services by region and stage of development.

In most countries, the NMS is the leading or sole institution that manages the agrometeorological networks (from 51.3 percent in North America and the Caribbean to 96.2 percent in Africa). Only 39 NMSs stated that they play a minor role and 7 do not participate in observation and monitoring for agrometeorological purposes. In Africa, 11 services playing minor roles and 2 services are not involved in agrometeorology and in Europe 10 services play a minor role. Based on stage of development, 100 percent of observation and monitoring are carried out by the NMS in the LDC, 83.7 percent in CIT, 73.9 percent in developing countries, and only 50 percent in developed countries.

A high proportion of the NMS stated that they provide agrometeorological services. However, except in the CIT, not all those doing the observation and monitoring provide agrometeorological services. The agrometeorological services are provided by 83.3 percent of the NMSs in LDC, 87.7 percent in CIT, 69.6 percent in the developing countries, and 50.1 percent in developed countries. Almost half of those in developed and more than 30 percent in developing countries do not provide agrometeorological services probably indicating the diminishing share of agriculture to the economy. The other reason, both in the developing and developed countries, is that there are many other institutions both private and public that have the capacity and are providing the services.

The NMS running observational and monitoring networks have maintained valuable long historical records, either as hard copies or digital databases. But, valuable data are not always utilized for the benefit of the farmers. The problem seems to be very serious in the South West Pacific and Africa where only 62.5 percent and 68.0 percent of the services that stated they are the sole or leading institutions are doing agrometeorological observations and providing services. In Asia and Europe, the proportion of those doing observation and monitoring and also providing the service is higher, 92.3 percent and 81.5 percent, respectively. The fact that many countries do observations but do not provide services indicates the pressing need of capacity building, particularly in analytical methodologies. Raw data are of little value and hardly understood by farmers without being transformed into information by good analysis.

Besides participating in formulating national policies on natural disaster reduction, environmental protection, and sustainable development, the NMSs are also involved in international programs such as United Nations Framework Convention on Climate Change (UNFCC), Vienna Convention on the Protection of the Ozone Layer, and the UN Convention on Combating Desertification (UNCCD). A high proportion of NMSs play a leading role, 81.5 percent in Africa, 70.8 percent in Asia, and 81 percent in South West Pacific, but only 44.4 percent, 60.0 percent, and 59.0 percent respectively, in South America, North America and the Caribbean, and Europe. Probably because the research infrastructure and institution are more developed in the industrial world, the role of meteorological services in UNFCC is lower when the country is more developed. The role of the UNCCD was more significant in Asia and Africa with 54.5 percent and 40.7 percent, respectively, compared with only 16.6 percent in South America, 26.7 percent in North America and the Caribbean, 20.0 percent in Southwest Pacific, and 28.6 percent in Europe. The problem of desertification is less predominant in the last four regions.

A lower proportion of professional staff and a low operating budget, in the less developed countries where the clients are mostly marginal farmers with inadequate means to access the information, certainly affects the quality and delivery of the services. Unfortunately, the less developed countries do not have adequate resources to address this problem. Modernization and capacity building are only possible when adequate budgets are available. Further, many developing countries give greater priority to the most visible and quick yielding programs. With few exceptions, it is hard to expect that NMS will focus on providing appropriate services to agriculture. Without assistance from more developed countries or related international institutions, the problem will take a longer time to be solved.

The NMSs also do not put significant efforts into providing information to serve human health and medical services, although most of the public health problems are related to climate. For example, dengue fever, caused by mosquitoes during monsoon, or respiratory diseases caused by hazes in prolonged droughts. Triggered by heavy rain during climate anomalies, epidemics of rift valley fever have decimated livestock and affected humans as well in East Africa. Pollen of particular plants is also known to spread over wide areas and affect human health.

In the survey of the economic sectors that were served by NMSs, health and medical services ranked 17th both by region and stage of development. It ranked 12th in Africa after tourism, 13th in Asia after construction, 18th in South America after sports, 16th in North America and the Caribbean after legal services, 20th in South West Pacific after leisure, and 23rd in Europe after urban planning. The more developed the country, the less significant the role of NMS in providing information on health-related matters. High investment in health services in the more developed world may have negatively affected the initiatives of the NMS to venture in this field.

Agricultural User Categories

Agricultural users can be roughly divided into four broad categories: 1) farm operations and farm management; 2) agricultural institutional support systems; 3) agricultural policy and planning; and, 4) agricultural research and education. Each of the groups (and their sub-groups) requires specific agrometeorological information for the safety and sustainability of the business. For agricultural institutional support systems and agricultural policy and planning, a more general type of agrometeorological information such as monthly rainfall and temperature along with spatial and temporal climate variability are usually adequate. For farming operations and research and education, more detailed information is necessary. Farmers require detailed information when deciding on the appropriate time for land preparation, planting, spraying insects, or harvesting crops. Researchers, on the other hand, require detailed information to understand the intricate interactions between plant, soil, and climate.

The farming management practices specifically include annual and perennial crops, forestry, animal husbandry, inland, freshwater and brackish water fishery, and mixed or integrated agriculture where two or more of the ventures are actually practiced on one piece of land. When the farmer cultivates crops along with trees next to each other on his farm, the production system is referred to as agro-forestry. By arranging plants in a multiple storey way more solar radiation is absorbed by the vegetation from the same size of land. Trees are also planted as a fence or wind barrier to protect the crops from strong wind. Each of these practices requires very specific information for the selection of production systems to decide which is the most suitable for a particular piece of land with a unique combination of soil and climate.

Among the agricultural institutional support systems are: agricultural extension services, financial institutions like rural credit, insurance, seed growers, etc. The extension service needs adequate knowledge of the general climate of the area and how that affects the farming practices in the area. Rural credit, insurance, and seed growers require long-term climate forecasts to know what type of venture they are going to make in the coming season or year. Forecast information is needed in advance, so the timely release of forecasts is imperative for a more profitable business.

Agricultural policy makers and planners require comprehensive soil and climate information to plan new agricultural ventures. Facing the ongoing change, such as regional cooperation or competition from other producers, agriculture has to adjust. With proper planning, agriculture in developing countries can be a way to pursue political, economical, social, and environmental goals. For political goals, agriculture can be re-planned to strengthen national integration through promoting inter-regional trade within the country or region. Economic goals can only be achieved when the agriculture products can compete on broader markets. Social goals such as rural development and poverty alleviation are strongly associated with agriculture, because farmers in are in rural areas and they are mostly poor. For this purpose, agrometeorological information is indispensable, since it is one of the factors that cannot be modified in selecting suitable crops for a particular area.

The agricultural research and education institutions usually do not have adequate observational and monitoring facilities for agrometeorology, in terms of time and space. Agrometeorological data required by research institutions are usually rather detailed and precise on a daily or hourly basis. The database collected by the meteorological service with wide coverage both in space and time will be very useful in understanding the dynamic nature of agrometeorology. Delineation of somewhat similar combinations of soil and climate in one region is commonly called the agroecological zone, where crop cultivation with all management aspects can be expected to perform similarly. This approach will help the agricultural research to easily find where to transfer the agricultural technology generated in the experimental stations.

Agrometeorological data can be further analyzed to determine how they affect crop performance to understand the intricate relationship between crops, soil, weather, and management. Simulation models constitute the ideal tool to carry out these analyses. Before they can be used, the models must be tested and validated in different places, which requires a good dataset of all variables involved. This includes not only agrometeorological data but also crops data such as phenology along with management that has been applied. From the experimental and research results, useful feedback can be expected on necessary data required that are presently not available to run the models for a wider application. Therefore, a continuous communication and consultation between NAS and research is imperative, to improve the services provided to farmers as well as the advancement of knowledge. With better understanding of the relationship between agrometeorology, crop, soil, and management, the NMSs can prepare better services to the users.

Crop Farming

A great variety of farming systems exists in different parts of the world. Earlier, before trading existed, driven by the basic needs for subsistence, farmers usually cultivated staple foods. With the advancement of transportation and trade, farmers with sufficient land gradually moved from food security as their main objective to crops that provide the best return. But, many small farmers in the developing countries, because of the limited land availability, tried to intensify the use of their small farm by cultivating various field crops at once in a system called multiple cropping. This is also part of the strategy of poor farmers for food security: in case one crop fails, the other provides a substitute.

Farmers take the harvested parts of the crops (flowers, fruits, grain, or tubers), but often leave the straw, stalks, or haulms in the fields as compost. To better utilize crop residues, farmers raise animals, poultry, and small or big ruminants depending on the quantity of the residues. Chickens and ducks are often raised to control insects and other predators. When adequate amounts of water are available (as indicated by a continuous surplus in the water balance), farmers can raise fish in ponds, where parts of the agricultural waste can also be recycled. All these agricultural activities require a better understanding of agrometeorology, for both the selection of an appropriate production system and for the day-to-day management of farms. Each crop requires specific agrometeorological information for better growth, and a combination of resources is certainly needed to balance the requirements for the best outputs. The list of crop-based farming systems for food, horticulture, and industrial crops are presented in Appendix 1.

Animal Husbandry

Animals can be raised in open fields and left grazing or confined within their pens and be provided feed. The selection of the type of animal raised in a particular region requires very general agrometeorological information. For instance, water buffaloes need humid conditions, while dairy cattle require cooler temperatures compared to beef cattle. Goats can stand harsh climate such as dry and hot desert but those conditions are not suitable for sheep. Ducks require large amounts of water but chickens will be adversely affected by high humidity. When land is in short supply and transporting the products to the market becomes a constraint, animal husbandry is moving closer to the consumers in peril-urban areas. Large animals like beef cattle, such as 1-year old calves, are brought close to market and kept in pens for fattening before being slaughtered.

Because animals are kept on limited space, the climate can often be managed. Animal husbandry produces not only meat, but also honey, milk, eggs, fleece, and hides. Those outputs probably require specific agrometeorological conditions for optimum yields. For instance, honeybees require high solar radiation that induces plants to flower and favor the production of nectar.

Fisheries and Aquaculture

As land grows scarce due to increasing population, fisheries are often seen as a valuable alternative source of protein. Unfortunately, fish catches in international waters already exceeded the sustainable limit, thereby jeopardizing their very existence. Aquaculture, i.e., fish farming both on land and in the sea close to the land, has become an attractive option for the future. Aquaculture includes fresh water fisheries where farmers raise carp, tilapia, catfish, snakehead, and others and brackish water fisheries where farmers raise shrimp or milk fish. Aquaculture requires water bodies where the fish are raised for a certain time period, if necessary in man-made ponds.

Along with soil information, agrometeorological information is needed to establish aquaculture schemes. Essential information is derived from the local water balance, where surplus water is necessary during most of the year if rainfall constitutes the main source of water. Otherwise, to keep the fish ponds full of water, other water sources have to be found. For brackish water fisheries, a specific balance between fresh and saline water is required for both shrimp and milk fish, as rainfall is a source of fresh water that cannot be controlled. It is very important to know the right amount of fresh water supplement from other sources.

Forestry

With the size of natural forests declining, particularly the tropical rain forest, efforts in re-forestation or replanting the degraded forest using fast growing trees presently has become a trend. It is still highly disputed whether this is the best approach, since by planting only a few species bio-diversity is lost, as well as the intricate interactions that prevail in natural ecosystems.

Leaving forests to naturally grow to near-initial conditions will take hundreds of years, a timeframe far exceeding the term of any administration. Therefore, for a quick result, many public lands of the former natural forests are leased to private companies for wood tree plantation. Fast growing soft wood trees are usually planted for pulp to produce papers or timber for packing or disposable wood products like toothpicks or chopsticks.

Other than finding which particular wood species are suitable, foresters are very concerned with forest fires in some parts of the world. Forecast of relevant elements such as temperature, humidity, and wind may be required during the dry season when fires commonly occur. The NMSs may also need to monitor the dryness of the forests to keep the public informed of the degree of danger of fires each day. When the danger is extreme, a warning will be required. Another requirement may be forecasts of calm conditions for aerial spraying of insect pests.

Agrometeorology Data Requirements

Factors Reducing Yields

For optimum growth, crops require heat and water as well as plant nutrients. Except for a few like mushrooms, plants need solar radiation for photosynthesis to produce the harvested parts. Crops will produce optimally when all the requirements of nutrients, water, heat, and solar radiation are satisfied in all stages of growth. Potential yield is determined by crop genotype and environmental conditions (including management) and can be reduced below the expected value because of limitations to the accumulation of dry matter during specific phases of growth. Attainable yield, determined as well by water availability and extreme meteorological conditions, can additionally be affected by restrictions on the initiation of harvested parts of the crops such as flowers, fruits, grain, or tubers. The ratio between actual and attainable yield can be further reduced below normal by prolonged delay in the essential farming operations that affect crop establishment. The yield is also affected by timeliness of fertilizer and biocide applications and by harvest effectiveness. Meteorological phenomena that are mostly responsible for the yield reduction are: low temperature or frost, high temperature, excessive rainfall, insufficient rainfall, excessive wind speed, and low solar radiation. The most common agrometeorological variables, and how they affect crops, are presented in Table 1.

Variable	Effect
Daily minimum temperature	frost damage; lower limit of temperature tolerance
Daily maximum temperature	heat stress
Daily mean temperature	rate of crop growth and production
Atmospheric humidity:	
Lower limit	desiccation
Upper limit	crop disease indicator
Wind speed	crop mechanical damage
Excessive rainfall	water logging, crop inundation, trafficability, disease
Solar radiation:	
Upper limit	rate of maturing
Lower limit	delayed grain filling, raised moisture content
Excessive evaporation	crop stress
Soil water shortage	drought
Soil water excess	water logging
Actual/potential evaporation	prolonged low ratio implies crop stress

Table 1. Agrometeorological variables and their effects on crops.

When the limiting factor for crop growth is water, farmers resort to irrigation and drainage. Certainly these can only be carried out when the water resources and the means to withdraw it are available. Farmers in developing countries have traditional ways to deal with water excess by preparing the fields using the ridge/furrow system, planting crops that cannot stand water logging (corn, legumes) on the ridge, and rice in the furrow. However, when the problem is heat, solar radiation, or strong wind it will be very difficult and expensive to rectify the weather conditions except for those crops planted in greenhouses.

Weather also will affect agricultural activities in the field from land preparation, sowing, fertilizer application, plant protection, harvest, and post harvest activity. Excess or shortage of water will make the tilling of heavy clay soils very difficult and expensive. As in many of the more developed countries, with less and less farm workers doing rice transplanting in Asia, a new technology of rice planting (direct seeding) is widely applied. The application of direct seeding requires precise information on rainfall because heavy rainfall will wash away the seeds that were broadcast in the fields. High rainfall also will hinder the broadcast fertilizer application and spraying of biocide for plant protection.

High rainfall and wind speed will adversely affect harvest and post harvest activities. Certainly the harvest can be delayed, but it will reduce the quality of the crop. Drying grain in periods of high rainfall will be difficult and expensive. In Cauca Valley of Colombia where sugarcane is a major commodity, for easy handling, the canes are usually burned before harvesting. The smoke from the fire will disturb the population in nearby settlements; therefore, wind direction is essential information required to schedule the burning of the canes in order to minimize the adverse effects.

Importance of Phenology

Crops require specific agrometeorological conditions at different growth stages and different crops require different conditions. The growth stages are divided into initiation, establishment, vegetative, reproductive, and ripening. Shortage or excess of water, heat, and solar radiation at particular stages of development will have adverse effects on the crops. Crops generally require high amounts of water during the vegetative phase but less water and high solar radiation during reproductive stages. Specific agrometeorological conditions also induce the flowering of some crops.

Weather during early growth is very crucial for further development of crops. Adverse weather conditions may delay crop growth or even kill the germinating seed, therefore requiring replanting. Temperature and water content of the soil will determine whether the seed broadcast in the field will germinate. Even the establishment of winter cereals such as wheat and barley is greatly harmed when the temperature falls below 3°C and shortage of water will cause uneven establishment in the field. Therefore, more precise information on agrometeorology is required in determining the right time to start sowing or planting.

***Crop*/Growth Stage**	**Temperature**	**Rainfall/Moisture**	**Wind**	
Rice				
Establishment	≤ 10° C, ≥35° C	> 25 mm/d after sowing		
Vegetative	≤ 10° C, ≥ 27 night	AE/PE < 0.3 for		
	≥ 32° C day	≥ 30 d		
Reproductive	≤ 10° C, ≥ 27 night	continuous rain	≥6.7 m/	
	≥ 32° C day	AE/PE < 0.3		
Ripening	≤ 13° C, ≥ 27 night	continuous rain	≥6.7 m/	
	≥ 32° C day	AE/PE < 0.3		
Harvest		continuous rain		
Wheat/Barley				
Establishment	≤ 3° C for ≥ 30d from sowing	> 25 mm/d after sowing		
Vegetative		≥ 100 d flooding		
	≤-10° C for 10 d	AE/PE < 0.3 for ≥ 30 d		
Flowering 1° C for ≥ 2 d	≥ 32° C for 1 d AE/PE < 0.3	3 mm/d continuous + 12 h rain	≥6.7 m/s	≤-

Table 2. Alarm criteria for selected crops during different stages of growth.

Seasonal Forecasts

When reliable forecast of the coming seasonal weather is available in advance, risk analysis and assessment of different cropping and management options can be performed to select the best one. Farmers can benefit from various crop options with different weather requirements and expanding markets to make the best from expected seasonal weather. However, this requires good planning, particularly the availability of the necessary seed, etc.

Forecasts can provide useful guidance to agricultural communities by informing them of expected weather conditions in time to schedule farming operations such as plowing, planting, irrigating, spraying, and harvesting or to take action to reduce losses from drought, flood, or other severe weather phenomena. They can also assist in scheduling the transport to market of vulnerable produce, so that potentially damaging weather conditions like freezing temperature that can damage potatoes and other vulnerable crops are avoided en route (WMO, 1999).

Warning Systems

When adverse effects of weather on the already planted crops cannot be avoided, it is very important to assess the impacts not only on farmers but also for society and the country. There are three steps of precaution on the possible adverse effects of weather on crops; those are warning, alert, and alarm (Keane, et al., 1998). Warning is issued when the adverse effect is small and in a limited area, alert is issued when the effect is higher over a wider area. For a real-time coverage of wide areas, the use of external data such as radar and satellite imagery along with the data from observational networks is required for the assessment. Specific agrometeorological conditions are said to be alarming, used when the possible impact on crop yield reduction is exceeding 20 percent over an area of more than 10,000 $km^{2,}$ or yield reduction of more than 30 percent over 5,000 km^2. Alarm criteria for selected crops at different stages of growth are presented in Table 2.

Strengthening the National Agrometeorological Service

The Institutional Position of Agrometeorological Services

As stated at the Commission for Agricultural Meteorology's 13th Session (CAgM-XIII), legal instruments and capacity building are relevant issues on the role and operation of the NMSs. The survey also indicates that almost a third of the NMSs operate based on ministerial or lower administrative levels when the rest are established on a higher legal basis, either on parliament acts or presidential decrees. This will put them in a less authoritative position in dealing with other sectors and also affects their budget allocations. The majority of the NMSs are under the Ministries.

Transportation and communication budgets are comparatively lower than other sectors, even within the same ministry, compared to other areas such as aviation, shipping, and land transport systems. Since national organization set-up is a matter of national policy, it is desirable that in countries where agriculture is still an important economic sector and an important employer, to put more emphasis on agrometeorology.

Agriculture is a dominant activity in many developing countries and in some developed ones as well, so that the provision of services to agriculture should receive very high priority. But the NMSs often face constraints, that either because they are not equipped to provide appropriate services or the institutional infrastructure does not permit them to reach the end users, or both. A better service to agriculture can only be implemented by strengthening the agrometeorology section where it already exists, and by developing one when necessary. Effective services can be attained by closer cooperation with the Department of Agriculture, particularly in interpreting the agrometeorological events and their relevance to farming practices as well as in delivering the information to the farmers.

Using the observational networks, long historical series of meteorological data have been collected, and in many cases, put into a computerized database. However, the data remain in the services and are not used optimally for the benefit of the farming community. The absence of agrometeorological services in many countries that have observational and monitoring networks is an indication of the shortcoming in the analytical capability of some of the services. Valuable data that have been stored into databases are often understood by and accessible to very few people, mainly those who are involved in planning and collecting. In the agricultural sector, those data will be very useful if they are made available to the research and educational institutions in an attempt to further improve the understanding of climate and how it relates to crop growth and agricultural activities. In order to reach a wider community of users, analysis is needed to transform the data into information. Information, in turn, has to be regularly delivered to the public in the form of forecasts and, when it is of urgent nature, timely advisories or warnings given.

New Methods and Tools

There has been enormous progress in the development of new methods, tools, and sources of data in the last decade. Many easy to use and free statistical packages tailored for climate data analysis are presently available. They can often be downloaded from the Internet. One example of a statistical package is Instat+ developed by the Statistical Service Centre, University of Reading. It has extensive climatic analysis tools and provides a specific "climatic guide." However, a more powerful analytical program is required for advanced analysis, particularly when intended to serve specific government in areas such as food security.

FAO has embarked on developing AgroMetShell (AMS), a combination of climatic database, analysis, and decision-support system (DSS). It includes crop water balance, crop satisfaction index, satellite data interpolation, as well as interpolation techniques to convert point data into maps. Certainly, the packages can only be of any use when trained personnel and equipment such as computers are available. Capacity building should be a priority for the NMSs to improve the technical skills of the staff in analytical methodologies and the use of computer tools.

Only after their analytical capacity has significantly improved can the NMSs embark on the development of a DSS for more specialized agrometeorological services. In a specialized service, cost recovery can usually be negotiated with the intended users such as commercial agricultural businesses. A DSS and the simulation of the implications of alternative actions to be taken to minimize the risks are desirable to provide better service to the users. The development of DSS requires the expertise and the close cooperation of many experts such as agrometeorologists, agronomists, soil scientists, as well as anthropologists and other social scientists. This will require a close collaboration also among different government departments outside the NMS.

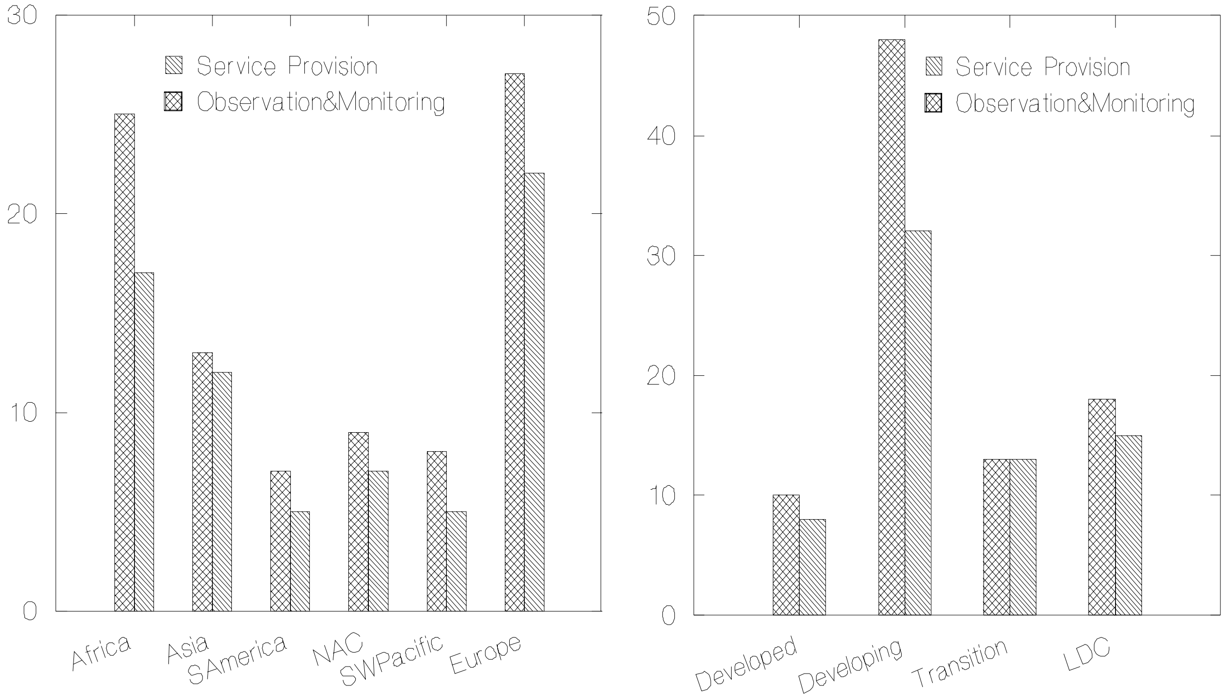

Figure 2. Number of national meteorological services with agrometeorological observational and monitoring networks and service provision.

Capacity Building and Regional Collaboration

Certainly, capacity building, particularly human resource development is not a simple task for resource poor countries. Furthermore, the efforts will take a relatively long time to give clear and significant results that are often beyond the time frame of democratically elected governments.

Another more plausible approach in improving the capacity of the NMS is strengthening regional cooperation by developing regional centers like the European Centre for Medium Range Climate Forecasting. By putting together all the best resources such as expertise and equipment, the Centre can better serve not only Europe but the other parts of the world as well. The services of the Centre are very useful to the CIT in Central and Eastern Europe.

Driven by the catastrophic droughts of the 1970's and 1980's, regional collaborative work was strengthened in Africa such as Southern Africa Development Community (SADC), Inter-governmental Authority on Drought and Development (IGADD) in Eastern Africa and CILSS in the Sahelian region of Africa. CILSS established its Agrhymet in 1974, a regional centre that specializes in providing services to member countries particularly to ensure food security.

Southeast Asian countries organized a workshop in 2001 to forge close cooperation on agrometeorology and have established working groups on meteorology and geophysics. The working groups among others, monitor forest fires and haze during prolonged drought, repeatedly causing economic losses in the regions.

Climate Change, Desertification, and Biodiversity

Long historical data series collected by the NMS will be of great value in improving understanding of global concerns such as climate change and desertification. It is the time to start exploring the proper ways to mitigate climate change and desertification and to find proper adaptation strategies in facing what looked inevitable. Agriculture can reduce greenhouse gas emissions by adjusting the farming practices to achieve higher production while reducing unnecessary release of wastes from crops and animals. The trend and development of climate change and desertification either natural or human made also have implications on another global concern, biodiversity. The loss of biodiversity is further aggravated by population pressure in the less developed countries that exploit the natural habitats for their meager living.

A diverse range of organisms contributes to the resilience of agricultural and natural ecosystems, their capacity to recover from environmental stress, and their ability to evolve (www.fao.org/biodiversity, 2003). Further losses of biodiversity have to be prevented and the NMS can play an important role in this effort by providing necessary climatic information required for the conservation of the genetic resources.

Improved Weather Forecasts

In the last decades, we have seen enormous increase in the accuracy and lead time of forecasts and warnings due to the introduction of computers and satellites. This trend can be expected to continue as more sophisticated numerical models of the atmosphere and oceans are developed. Improved analytical software run on smaller computers, provided they have a sufficiently dense network of observations as input, and will increase the accuracy and resolution of forecasts for limited areas of high economic value (WMO, 1999).

Using advanced software and inputs from extensive observation networks, some national and international institutions presently provide analytical results such as climate outlooks and forecasts with global coverage, which are posted periodically on their websites. Among others, the International Research Institute for Climate Prediction releases four trimester forecasts of temperature and precipitation every month. The National Weather Service of the National Oceanic and Atmospheric Administration of the United States provide a weekly update on the development of Pacific Ocean sea surface and subsurface temperature as an early indication of the development of an El Niño event. Greater understanding of El Niño and similar phenomena in other oceans, together with improved computer models, should also lead to more reliable seasonal forecasts and prediction of drought some months ahead (www.cpc.ncep.noaa.gov/products, 2004; www.iri.columbia.edu/climate/cid, 2004). This valuable information can be accessed by Internet. It is well worth being calibrated with the data observed by the NMS and it will be very valuable when used for agriculture planning in the country.

Acknowledgements

The author extends his profound gratitude to Environment and Natural Resource Service of the FAO, especially Dr. René Gommes, Senior Agro-meteorologist for all his valuable suggestions in preparation of this paper.

References

FAO. 2003. FAOSTAT. Rome, Italy: FAO.

FAO. 1986. FARMAP: User's Manual Vol. 3. Appendix B: Full Code List. Rome, Italy: FAO.

Hough, M.N. 1998. Examples of alarms situations from the UK. In Agrometeorological Applications for Regional Crop Monitoring and Production Assessment. Ispra, Italy: Joint Research Centre, European Commission.

Keane, T., G. Russell, M.N. Hough, and D. Rijks. 1998. Alarms. In Agro-meteorological Applications for Regional Crop Monitoring and Production Assessment. Ispra, Italy: Joint Research Centre, European Commission.

WMO. 1999. Guide to Public Weather Service Practice. Geneva, Switzerland: WMO.
www.cpc.ncep.noaa.gov/product. 2004. El Niño/Southern Oscillation (ENSO) Diagnostic Discussion. Washington, D.C.: NOAA.

www.fao.org/biodiversity. 2003. Biodiversity Awareness. Rome, Italy: FAO.
www.iri.columbia.edu/climate/cid. 2004. Climate Information Digest. New York: IRI.
www.rdg.ac.uk/ssc. 2003. Instat+. Reading, United Kingdom: University of Reading.
www.wmo.ch/index/. 2003. Major Issues. Geneva, Switzerland: WMO.