Improving Agrometeorological Bulletins
Perspectives from RA II (Asia)

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Introduction

The WMO Regional Association II (Asia)

The terms ”RA II“ and/or “Asia“ are used to describe that area including the countries and territories encompassed in the WMO Regional Association (RA) II (Asia). The 34 Members of RA II, are listed alphabetically below:

Afghanistan, Islamic State of
Bahrain
Bangladesh
Cambodia
China
Democratic Peoples Republic of Korea
Hong Kong, China
India
Iran, Islamic Republic of
Iraq
Japan
Kazakhstan
Kuwait
Laos Peoples Democratic Republic
Macao, China
Maldives
Mongolia
Myanmar
Nepal
Oman
Pakistan
Qatar
Republic of Korea
Republic of Yemen
Russian Federation
Saudi Arabia
Sri Lanka
Tajikistan
Turkmenistan
United Arab Emirates
Uzbekistan
Viet Nam, Socialist Republic

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The RA II covers a vast expanded area of the Indian Ocean and a part of the Pacific Ocean, and contains a large and diverse range of ecosystems, including desert, forests, rivers, lakes and seas. The desert extends from east to west, encompassing Central and Western Asia.

The Asian region is the fastest growing economic region in the world. The strongest economies in the Region are those of Japan and the Republic of Korea. In the last few years, a number of countries - most notably some member nations of the Association of South-East Asian Nations (ASEAN), China and India - have had impressive economic growth. The oil- and gas-producing countries, the Gulf Cooperation Council (GCC) and the Islamic Republic of Iran, have wealthy economies. The total population of the RA II was estimated to be around 3 395 million inhabitants by the end of 2000. Asia has two of the world's most populated countries, China and India. The region also includes some of the least developed countries such as Afghanistan, Bangladesh and Nepal.

Compared to the other WMO Regional Associations, Asia includes the highest mountains, the rainiest areas and the driest deserts, with their associated variation in culture and biodiversity. Over the long period of human occupation in Asia, exploitation of natural resources, urbanization, industrialization and economic development have led to land degradation and environmental pollution. Climate change and climate variations also represent future stress.

The major challenges to the development of nations include natural and environmental disasters, climate change, climate variability, water management, over-fishing of coastal and sea resources, freshwater resources management and development, land use and land degradation, energy availability, tourism management, poverty alleviation and conservation of biodiversity. Weather and climate observations are required to address these issues, which are of relevance to the present social and economic conditions as well as for those of future generations.

The Need for an Official National Meteorological Service

Governments have historically established official NMHSs in many forms to provide daily forecasts and information services to the public, specific data and information to decision makers and planners on the countries' natural resources, and advice to authorities in civil aviation, agriculture, forestry and marine transport, water and energy, tourism and others. The NMHSs cooperate at the regional and global levels by exchanging meteorological observations according to national obligations and commitments of regional and international agreements and conventions.

NMHSs in the Regional Association II (Asia)

The NMHSs in the RA II vary in size, status of advancement, geography and state of development and, therefore, are highly differentiated in capabilities. The gap is wide, from the most developed NMHSs having super-computers for modeling and specialized meteorological centers, to the less developed NMHSs having limited budgets, shortages of observation instruments, spare parts, and consumables, lack of calibration equipment, data collection, processing and communication facilities, and under-qualified staff.

The legal basis for the creation and operation of NMHSs varies between countries. Some were established under national laws (Acts of Parliament or Royal Decrees, etc.), while others were established by other subsidiary forms. Institutionally, some NMHSs report directly to ministers, prime ministers, and heads of state; others constitute departments reporting to non-ministerial systems; still others are established as units or divisions of departments.

Most NMHSs fall under the ministries of communication and transport, and/or the directorates of civil aviation. Few have combined services of environment and meteorology or hydrometeorology. Many also have the responsibility for seismology. Therefore, practices vary widely among the countries of RA II in respect to the extent to which the NMHSs are assigned national responsibility for monitoring, research and service functions related to environmental/geophysical disciplines of oceanography, hydrology, seismology and ionosphere physics.

The Role of NMHSs

The main role of NMHSs is the provision of weather and climate information, environmental monitoring, and other related services and activities to meet national responsibilities to contribute to the safety, wellbeing and protection of property of all citizens, and to provide sustainable social and economic development. In addition, they help to meet international commitments and obligations under various conventions, in particular the effective implementation of the WMO scientific and technical programmes.

The NMHSs are normally the official voice in issuing weather warnings for public safety, and are the primary national authority and official source of information and policy advice on the present and future states of the atmosphere and on other aspects of weather and climate in respect to policy development.

The NMHSs provide essential meteorological and related services for public safety and welfare. They collect and exchange meteorological and related data and associated products, especially through the practice of free and unrestricted data exchange agreed upon under Resolution 40 of the Twelfth Congress of WMO. Furthermore, they contribute to and support national strategies for sustainable development. They sustain environmental research and development of relevant applications, and maintain the integrity and continuity of long-term national climate records.

Current Status of Agrometeorological Bulletins in RAII

In order to assess the agrometeorological activities and related bulletins in RA II countries, a questionnaire was prepared and sent through the WMO Secretariat to all Member countries of RA II. The replies have been reviewed and briefed for consideration in an Inter-Regional Workshop. Out of 34 Member counties in RA II, 14 countries, namely Bangladesh, Qatar, Japan, Nepal, Viet Nam, South Korea, Uzbekistan, Kazakhstan, Mongolia, India, Thailand, China, Laos and Iran responded to the inquiry.

Existence of Independent Agrometeorological Service Units

The first question is related to the availability of agrometeorological services, dates of establishment, service providers and related bulletins. All 14 countries informed us that they were furnished with an agrometeorological service, which issued agrometeorological bulletins. Such activities in the 11 counties were conducted within their NMHSs.

However, in Qatar, agrometeorological activities are conducted within the Ministry of Agriculture, while in two other countries, Japan and Viet Nam, such operations are managed jointly by the Ministry of Agriculture and the meteorological organizations.

The Republic of Kazakhstan is the first country in RA II that initiated agrometeorological operations in 1922. Later on, India, China and Viet Nam joined this area of activity in 1945,1953 and 1960, respectively. Bangladesh was the last country to begin agrometeorological operations in 1986.

Issuing of Agrometeorological Bulletins and Advisories

The collected replies indicate that, with the exceptions of Qatar and Laos, all countries issue agrometeorological bulletins for their users on a regular basis. These bulletins are prepared in different forms in various countries because of independent observational methods.

In Uzbekistan, weekly bulletins are provided during the cultivating period to identify the best time for crop management. In Nepal, weekly bulletins just represent climate information. In Iran, weekly, monthly and seasonal bulletins include climate as well as soil and canopy information. Ten-day bulletins are regularly prepared in all countries except Qatar, Nepal, Thailand, India and Laos, and include different types of information. In Bangladesh and Japan only climate information is provided, while in the other countries, including Viet Nam, South Korea, Uzbekistan, Kazakhstan, Iran, China and Mongolia climate, soil and canopy parameters are observed and included in 10-day bulletins. In Mongolia, in addition to the above-mentioned types of information, pasture and animal husbandry related matters are also contained in 10-day bulletins.

In Bangladesh, Qatar, Japan, Kazakhstan, Thailand, India, and Laos no monthly bulletins are prepared, while in other countries monthly bulletins with information on soil, climate and canopy are given to users. In addition to weekly, 10-day and monthly bulletins, other kinds of publications, such as seasonal bulletins are prepared for each product based on observed climate, soil and canopy parameters in Bangladesh, Viet Nam, Uzbekistan and Iran. In particular, in Viet Nam special reports are prepared for climate related impacts on vegetation, forest, farming and other agricultural sectors.

Collection, Analysis and Presentation of Information in the Bulletins

The next questions explored sectors that provide agrometeorological services in the countries. The responses indicate that horticulture farming, fisheries, animal husbandry, forestry and crop production activities are archived in the NMHSs of Member countries. Bangladesh performs exclusively in the farming sector, while Japan, Nepal, Viet Nam and Thailand perform their duties with a wider scope in all the above-mentioned sectors.

However, there are still several countries that cover only part of this wide range of activities. In this context, 10 countries perform their duties in horticulture, 8 countries in animal husbandry and forestry, and 3 countries in agrometeorological observation.

In response to the operation of research stations on agrometeorology, it was revealed that in Bangladesh, Nepal, Kazakhstan and Laos there are no agrometeorological stations and agricultural centers merely record data for users. Agrometeorological observations in these countries depend on case requirements.

The number of agrometeorological stations vary between countries: Qatar has 3, Japan 7, Iran 23, Thailand 32 and China 34 stations. In Viet

Nam, about 15 stations out of the 129 agrometeorological stations are classified as principal ones and the remaining ones are subsidiary/auxiliary stations. In Uzbekistan 2 stations out of 5 are considered as specialized agrometeorological stations and the other 3 stations are called operational substations.

The Republic of Korea owns one principal and 9 auxiliary agrometeorological stations. In Japan there are a total of 7 stations for this purpose. In India, there are several agrometeorological stations that conduct study and research activities in four different regions, namely Pune, Rahur, Anand and Bangalore.

In Mongolia, two agrometeorological stations observe parameters on wheat and potatoes, and twelve other stations perform activities related to cattle, sheep and goats.

The agrometeorological weather forecast is one of the most important items focused on in these bulletins. In this context, short- and long-term forecasts bear particular importance in each bulletin, and users widely apply their information.

Short-term predictions are used in cultivating operations, with the suitable dates for the application of pesticides, irrigation, planting date and so on in different short-term periods.

Long-range forecasts based on statistical methods also appear in the bulletins issued by some countries, such as Bangladesh, Nepal and Laos. These kinds of predictions lack agrometeorological forecasts and they are only good for weather predictions with a leading time of 48 hours. In other countries, further to weather predictions, there are agrometeorological forecasts that may include some pieces of advice in the bulletins.

It should be noted that diverse requirements by users upon request might be met through the preparation of special bulletins giving the probability index in the forecast. Such special cases are among the additional obligations of these Services. Agrometeorological forecasts depend on the variety of vegetation and climate of the countries.

Considering the variety of climates in different Asian countries, most of the existing cultivated plants in the world are cultivated in the countries of this region. In this regard, for each cultivated plant, which has a prevailing role in the country, the agricultural meteorology related to it is studied and included in the bulletin provided.

Wheat is the main and important agricultural plant crop is studied

and observed in Bangladesh, Iran, India, and China. Parameters related to rice are observed in Korea, Uzbekistan, Iran, Thailand, India, China and Laos. Fruit trees and other orchard plants are also being observed from agricultural meteorology point of view.

Barley, maize and vegetables such as tomatoes, cucumbers, potatoes and flowers, grapes, oily plants and other cultivated and orchard plants are among the other cases that are considered for study and research in the field of agricultural meteorology. Some individual bulletins are provided in this regard for users.

All the countries in the region have agrometeorological databanks, including phenological observations for different cultivated plants, and data for soil and climate. Users classify these data for further processes. In some countries, the derived and analyzed data are available. Data quality controls based on standards are regularly accomplished.

The periods covered with climate data vary among the countries. The period ranges from 4 to 25 years among countries, but the maximum climate data period does not exceed 25 years. In some countries, climatic information covers a period longer than 70 years but data on soil and plants cover often relatively short statistical periods. Information in databases is recorded on paper. However, data files are usually provided on soft copies for the users.

Agricultural and meteorological statistics and data, including general information and bulletins for agricultural meteorology are offered free of charge in all countries, but in other countries, such as India and Iran, agricultural and meteorological data and statistics are free of charge only to researchers and scholars. The other users are expected to pay the relevant charges based on approved tariffs.

In Kazakhstan, additional costs for giving agricultural and meteorological data and statistics and bulletins received from private sectors are born by the user.

The Governmental sections receive agricultural and meteorological data and statistics free of charge.

Involvement of Agricultural and Extension Agencies in the Preparation or Dissemination of Agrometeorological Bulletins

The ways of transferring agricultural and meteorological data and statistics to the users are different among countries. In some countries, such information is disseminated on-line and via directs communication links. In

other countries, these data are provided on paper and mailed to users. In Bangladesh, Nepal and Laos, information is prepared on hard copy and sent to the users.

In Qatar, Japan, Viet Nam, Uzbekistan, Kazakhstan, Iran, Thailand, China and Mongolia, agrometeorological data and bulletins are provided in the form of hard copy and soft copy data files. In most countries of the region, news and information are broadcasted through the mass media in critical situations, particularly to farmers.

Mongolia, China, India, Thailand, Iran and Uzbekistan have a mass media system to disseminate necessary data during the growth period. One of the most important duties of NMHSs is Early Warning to mitigate the impact of natural disasters. In agrometeorological operations, these types of warnings can play a crucial role in improving service functions and lead to a better financial situation for farmers.

Regarding the personnel working in agricultural meteorology in RA II, responses indicated that the personnel training ranges from high school diplomas to doctorate degrees. Most personnel are working in the observation section and have a diploma or an associate of arts. At the professional level, a smaller number of personnel working in the station have Bachelor of Science or Doctorate degrees.

Of course, the number of experts in agricultural meteorology research sections is larger than of those who work in stations and executive parts. In the agricultural meteorology section, India enjoys the greatest number of experts holding Bachelor of Science or Doctorate degrees in its agricultural meteorology sector. In China there are six Bachelors of Science and two Master of Science degree holders. The number of personnel in these stations is distinguished from those of agricultural meteorological research sections.

In Thailand, there are about 113 experts, out of which 97 have diplomas and Masters of Science degrees. In Uzbekistan, there are 110 such experts and in Kazakhstan there are 130. More than 80% of them hold diplomas and the rest hold Bachelors of Science and Masters of Science. In Iran, there are 85 people, with 29 people having associate of art degrees, 40 people having Bachelor of Science degrees and the rest have Masters of Science and Doctorate degrees.

Considering the job training courses, the different agricultural meteorological training courses are held according to the needs of the sections. Bangladesh, Qatar and Laos are an exception, but in the case of

other countries different on-the-job training courses are justified and maintained.

Most countries hold their training courses in accordance with the Regional Meteorological Training Centers (RMTC's) rules for the agricultural meteorological courses. Joint training courses with universities is another kind of training which is being organized in most of the member countries.

In many countries in RA II, there are no training courses at all for a Master of Science or a Doctorate degree in the field of meteorology, forcing the people to continue their studies in the agriculture branch in other countries. Bangladesh, Qatar, Nepal, Kazakhstan, Laos and Mongolia have no advanced degree meteorological courses.

In order to provide specialized and skillful manpower in the field of agricultural meteorology, these countries usually use universities and facilities of other countries, regarding them as related educational branches. In Japan, there are 4 universities, which can grant Doctorate degrees in the field of agrometeorology. In Viet Nam, agricultural meteorology can be studied in a provincial university under the agriculture and natural resources career. This university holds the training courses in sections of the Master of Science and doctorate courses.

In South Korea, about 11 universities offer agricultural meteorological courses at the Bachelor Degree level, and each of them is located in one province of the country. The required manpower and specialists are trained according to local requirements.

In Uzbekistan, the department of atmospheric physics offers specialized courses for the agricultural meteorology. In Iran, the University of Tehran has established an agricultural meteorological field, and students are trained in the Master of Science section. At present, people are dispatched abroad to obtain the Doctorate degree in agricultural meteorology.

In Thailand, students are trained for Bachelor of Science and Master of Science in the University of Bangkok in the field of agricultural meteorology.

In India, opportunities for higher education, including Bachelor of Science, Master of Science and Doctorate degrees are available. There are several universities offering these degrees, including many agricultural universities.

In China, the Nanjing Meteorological Institute, the Agricultural

University and Shenyang Agricultural University are responsible for the training of experts for agricultural meteorology and provide the required manpower in this vast and varied country.

Other countries secure their manpower in the field of agricultural meteorology at the Bachelors level and above from other countries. More cooperation from the Members of the RA II regarding the training field has been proposed by all of the Member countries.

In the question relating to the participation of the private sector in agrometeorological activities, it was revealed that among the 14 countries, only Japan has both the public and private sectors operating in such an area. In the 13 other countries of this study, the Government is primarily responsible for agrometeorology.

Target Audience for the Agrometeorological Bulletins

In most countries, users of agricultural and meteorological data and statistics and their products, such as bulletins, are connected to governmental sectors. Farmers do not receive the information directly from the yearbooks, but they receive it through the Ministries of agriculture and natural resources, forests and pastures and animal husbandry.

In South Korea, Uzbekistan and Mongolia, the meteorological organization, in addition to providing data for the agricultural Ministry, offers such information directly to the farmers. In Kazakhstan, Iran, Thailand and India, these data are transmitted to the large farming and industry companies in addition to related agricultural ministries and organizations in the governmental sections. Sometimes specific bulletins are provided for these users. In all countries researchers and staffs of TV broadcasting and public media are considered important and essential users.

Effort to Obtain Feedback from Users of the Bulletins

The process of obtaining feedback is not carried out on a regular or systematic basis.

Effort to Assess the Economic Value and Benefit of Information Contained in the Bulletins

Evaluation of the effects of agrometeorological information and bulletins on the agriculture indicates that the farming is the sector most influenced by this information.

The analysis of the questionnaire shows the following rates of effectiveness:

60% in Qatar and Viet Nam, 90% in South Korea, 75% in Kazakhstan, 50% in Iran, 80% in India and China. In the horticulture division the rates of effectiveness is 25% in Qatar, 10% in Viet Nam, Kazakhstan and South Korea, and 20% in Iran and India.

For forestry, the rates of effectiveness are 10% in Viet Nam, Iran and India. For animal husbandry, the rate is 5% in Qatar, 10% in Viet Nam and China, 15% in Kazakhstan, and 30% in Mongolia. For fisheries, the evaluated rate of effectiveness is 10% in Viet Nam.

The results of the analysis indicate that most activities in the regional countries occur in farming and other activities like horticulture, fishery and animal husbandry, with variations according to the countries. In addition, there might be other activities of lesser importance.

Effort to Issue Specific Bulletins of a Special Nature

Early warnings are given in the forms of notifications and announcements by the NMHSs in all the countries, and are distributed to the authorities in the agrometeorological division to adopt measures for mitigation of the impact of natural disasters.

In some countries these warnings, in addition to NMHSs, are made by other organizations. For instance in Qatar early warnings are announced by the agricultural and water resources divisions. In Viet Nam, the Ministry of Agriculture is responsible for early warnings. In South Korea, they are made by a joint committee comprised of the Korean NMHS and the Rural Development Administration. In Laos, early warnings are made for users and relevant organizations by a joint committee from the weather prediction division and the flood prediction and warnings sector.

In some of the above-mentioned countries, there are defined systems to consider these early warning issues to mitigate the consequences of natural disasters.

Use of New Techniques such as Simulation Models and GIS

Regarding the data processing for agrometeorology, the countries provided different answers. Viet Nam uses GIS and modeling methods. Bangladesh, Nepal, South Korea and Laos do not yet have GIS and modeling in operational service yet. Japan uses GIS and modeling in prediction and crops growth measurements. Uzbekistan uses satellite data in agrometeorology considering cultivation area and functions. Kazakhstan uses GIS and modeling for grain prediction in agrometeorology. Mongolia, India and Thailand use various software facilities to make the agrometeorological data operational.

Shortcomings and Limitations in the Current Methods of Preparing Bulletins

Regarding the recommendations for the development of data transmission, the Member countries in the RA II stated that for a better use of agricultural meteorological information, data transmission and distribution should be accomplished through the design of Web-sites for the Internet.

For those who have no access to the Internet, these data can be distributed through traditional methods. In any case, the data transmission networks differ among Member countries.

At present, some countries are completely modernized and computerized, and others have not yet acquired the hardware and software facilities for a quick data transmission. However, any promotion and development should be recommended considering the existing situation of the countries.

The responses of the countries to the questions, show evidence that all countries welcome the establishment of a specialized Web-site in agricultural meteorology. It is believed that the best solution for improving and speeding up the flow of information is the use of the Internet and the establishment of a Web-site.

Comments and Suggestions to Improve Agrometeorological Bulletins

At the end of the questionnaire, the appropriate recommendation for the promotion and improvement of the situation of the agricultural meteorology in the RA II were requested.

From the results obtained from distributed questionnaires among the countries as well as the existing information in RA II regarding the agricultural meteorology, the following suggestions are proposed:

- Holding of more training workshops and giving consideration to short courses in agricultural meteorology.
- Exchange of data and agrometeorological knowledge between member countries and also the Inter-Regional exchange of these materials.
- Exchanges of experts between Member countries as a necessary way to improve the knowledge of agricultural meteorology.
- The use of meteorological forecasts and short- and long-term agricultural meteorological recommendations should be included in specialized bulletins for further notice.

- Performance of joint research between Member countries to solve common problems considering agricultural meteorological affairs.
- The use of GIS, modeling and joint training should be considered.

Implementation Strategies in RAII

For the provision of agrometeorological information in the form of a bulletin, the numerous steps from collecting raw data to final delivery to end-users should be taken. Depending upon domestic requirements and resources available, each country provides a region-specific set of agrometeorological information in diverse ways and formats. Unique formats have been employed in their contents, the methods of delivery, etc.

Bulletins also should communicate with end-users, including receiving feedback from them, and giving a focus to communication skills and methods. In addition, analysis tools, raw materials as well as human resources with appropriate expertise are required. Thus, any effort to make improvements on existing agrometeorological bulletins should include systems analysis of the whole scope of steps and methods that we should take during the production processes.

Components of Agrometeorological Bulletins

The common features of agrometeorological bulletins include giving general descriptions of agrometeorological characteristics of certain regions during the specific growing season through reflecting regional priorities in terms of agricultural production and resource management. Depending on the requirements and priorities of end-users, the description details or expertise levels of the contents vary to a great extent. In general, due to the shortage of expertise as well as the limited space of the bulletin, quantity or quality of information is often insufficient. Despite of all these limitations, the essential components for a successful bulletin can be identified as follows:

1) End-Users:
- Farmer, Associations, Extension, Researchers, Policy-Makers and General Public

2) Communication
- Sharing, Dissemination, Feed-back

3) Form:
- Digital / Document based (Paper)
- Bulletin, Brochure, Letter, Note, Leaflet, etc.

4) Data Format

- Text, Numeric, Table, Chart, Figure, Image, Map, etc.

5) Methods

- Phone, Fax, TV, Radio, PC-Network, Internet, Dedicated line, etc.

6) Contents:

- Type: General, Advisory, Warning, Recommendation, Suggestion
- Weather/Climate/Forecast/Prognosis/Diagnosis information
- Extremes, Energy Balance (Flux), Special Weather Phenomena (Flood, Drought, Frost, Heat wave, Fire, Land slide, Cold injury, etc)
- Applications to crops, Fruit, Grass, Forest, Animal Husbandry and Fisheries
- Impact on Growth, Development, Yield, Population, Reproduction (Phenological data, Eco-physiological parameters, etc.)
- Incidence of diseases, Insects, Pests and Weeds
- Farm Management (Cropping, Irrigation, Sowing, Harvesting, Post-Harvest, Spraying)
- Resource Management (Water, Air, Soil, Biome)

7) Developers/Producers/Authors/Publishers/Editors

- Meteorologists, Agronomists, Entomologists, Ecologists, Agrometeorologists,
- Soil scientists, Virologists, Epidemiologists, etc.

8) Raw Materials: Meteorological, Agronomic data, Non-Agricultural data

- Observed, Processed, Derived, Estimated (inter-/extra-polated)
- Numerical Weather Prediction (NWP) model outputs, Agricultural model outputs
- Domestic or Foreign Origin

9) Tools

- Statistical packages, Graphic tools, GIS, Simulation models,

10) Institution/Organization

- Meteorological, Agricultural, Hydrological, Others
- Research Institutes, Extension Office, University, Private Sector, Cooperation
- Local, Central (Federal), Regional, Global Organizations

Any bulletin should contain enough information to meet user requirements with the highest priorities in the region. In order to reflect these requirements, diverse data, tools, skills, techniques etc. should be also available to disseminate bulletins that have desirable levels of accessibility, relevance, timeliness, and accuracy.

Delivery methods available

Methods for the delivery of agrometeorological information can be classified into different groups depending on format and delivery. In terms of format, agrometeorological information can be disseminated in document, video, audio, and digital forms. Also, regarding the methods of information delivery, they can be grouped into mail, broadcast, phone fax, networks, by hand, etc.

There are several groups of methods of the communication of agrometeorological information. The classification below may seem too arbitrary, but it allows combining the format and delivery types into document-based, media-based, telecommunication-based, computer network-based and digital file-based methods.

1) Formats of information

- Documents, Video, Audio, Computer digital

2) Methods of Delivery

- Mail, Broadcast, Phone, Facsimile, Network, by Hand

3) Combined Classification

- Document-based: Bulletins, Brochures, Letters, Notes, Others
- Media-based: Radio, TV – Public, CATV, satellite

Journals

- Newspapers – General, Agriculture
- Magazine s– Monthly, Quarterly, Others
- Scientific Journals

- Telecommunication-based: Phone, Fax, Mobile, PDA, Others
- Computer Network-based: PC-Network, Internet – web, ftp, gopher, E-mail
- Digital File-based: CD, Floppy disk, Tape, Others

Shortcomings and Limitations

Contents

- Large uncertainties in forecast-based information
- Relatively simple and brief descriptions with historical data as reference
- Not very different from synoptic observation, insufficient number of elements
- Lack of detailed information to meet user's requirements
- Impossibility to deal with all diverse requirements
- Difficulties in timely delivery for on-farm applications
- Poor relevance of contents to end-users to some extent
- Lack of expertise, skills, techniques, tools in manipulating materials

Methods

- Data collection: sparse density of observations, non-automated data collection, poor quality control, insufficient number of elements, non representation of agronomic fields, delayed data collection and archiving, poor data management, etc.

- Data manipulation: insufficient knowledge and experience in data handling, insufficient number of raw data, expensive data processing software (e.g. remote sensing)

- Analysis process: poor understanding on mechanism and algorithms, lack of expertise and fundamental related information, lack of an integrated analysis system, mostly dependent on imported tools,

- Evaluation/Assessment: few evaluation systems, no experience in quantification of values and benefits, no criteria or references available, difficulties in nation wide survey or sampling, confounding effects by multi-factors, directly or indirectly.

- Publishing: poor hardcopy quality, limited space, poor skills in design and layout. High cost in time and money.

- Delivery: Many options but only one or two feasible, less efficient in case of non-specific users, high cost for special customers, time-lag due to delays, no guarantee of delivery on-farm site,

- Communications: mostly one-directional information dissemination, late response to or time- lagged outcomes from information provided, unstable and poor network performance, relatively high cost of advanced communication services in developing countries, no communication to remote or isolated regions.

Tools

Data Collection

Automatic Weather Stations (AWS), receiver and analysis systems for remote sensing, delayed data retrieval over remote location, few standardized agronomic data, sparse spatial resolution, unstable data collection due to poor connections, frequent missing data due to sensor sensitivity, limited sources for additional data collection. Long-term forecasts, with great potential in agriculture, are highly uncertain.

Data Management

Lack of dedicated computer equipment (server with sufficient capacity) for archival and database management system with high performance for large size of data manipulation,

Analysis: Statistics, GIS, Models

- Expensive software required to handle complicated data analysis
- High cost of GIS packages with appropriate attributes and vector data for spatial analysis
- Complicated simulation models to conduct integrated assessment in agro-ecosystems
- Very difficult to develop own analysis system. Even calibration/validation requires time, labor and money.

Presentation

- Graphics, Hard Copy, Design, Layout
- Finding comparatively easy part to equip with necessary tools for presentation

Infrastructure

Human resources: Always the most critical limitation in every agrometeorological activity in developing countries.

Organization:

- Sometimes no dedicated organization to take care of agrometeorological bulletins
- Poor collaboration between meteorological offices and agricultural offices.
- Reduced priorities in agrometeorology because of poor recognition of importance
- Bureaucratic barriers against interdisciplinary solution-finding efforts

Hardware

- Limited availability of computer facilities, with poor networking capacity at national level
- Insufficient surface observation with few supplementary boundary-layer observations
- Limited remote sensing such as RS, RADAR, Global Positioning System (GPS) technology and analysis system in related institutes

Software

- No auxiliary computer software available for additional support

Financial Sources

- Lack of continuous support to secure financial sources for operational services

Information Systems

- Limited supplementary data supply system from non-agricultural sectors

Public Recognition

- Low-level reputation from the general public or poor recognition by the public of the importance of agrometeorological services

Social Efficiency

- Low system performance at social level in terms of investment efficiency
- Low cost/benefit rate compared to that of developed countries

Implementation strategies

Strengthening of National Infrastructure

Priority

Overall performance of agrometeorological bulletins can be evaluated in terms of their contribution to user requirements in terms of timeliness, effectiveness, feasibility, practical aspects, economic value, infrastructure enforcement, productivity, system stability, etc. Above all, the national priority on agriculture will be a critical driving force for a successful bulletin at a farmer's site or at governmental offices. Given the highest priority, it is natural to have strong support from the government in finance, human resource, facility, equipment, research projects as well as other facilities.

Recognition

End-users such as farmers also can play an important role in activating agrometeorological bulletins by their strong demands for agrometeorological information for their farming. Obviously, the farmer's recognition of the importance of agrometeorological information should be high enough for all information leading to increases in productivity or the stability of agricultural production to a considerable extent.

Expertise

In order to meet the user's requirements on time, there should be a sufficient number of experts available in almost all disciplines of agriculture and other supporting disciplines such as computer technology, etc. Except for several developed countries, most countries suffer from a shortage of domestic experts in this regard. This necessarily leads to a poorer quality of agrometeorological information. The problem lies in the fact that securing a sufficient number of experts appears to be non-feasible, for the time being, in many countries due to limited resources or limited chances of educating or training to such an advanced degree of expertise in a short period of time.

Resources

Furthermore, systematic operation for the distribution of agrometeorological information will inevitably rely on national infrastructure such as communication networks, mass media, transports, and other delivery tools. Among the diverse components of agrometeorological bulletins, timely delivery of information is the most critical factor in the effectiveness of the overall performance of a bulletin. When this requirement fails to be met, the total value naturally becomes small or even worthless in certain cases.

Willingness

Finally, the willingness of utilizing the level of understanding of agrometeorological information with appropriate application skills of end users are two other critical elements that will decide the effectiveness of agrometeorological information systems at the operational level. Therefore, continuous education or training for end users on new knowledge, technology, and tools is very important to accomplish the ultimate goal at farmers' sites. National agrometeorological service should include on-going education systems for various levels of end-users in agriculture.

Policy + User Requirements + Expertise + Resources + Communication + Effectiveness

NationalPriority ***User's Willingness***

National Infrastructure

Improvement of Current System Efficiency

The feasible alternative to infrastructure strengthening is to improve the efficiency of the current system for agrometeorological bulletins as much as we can improve the use of available resources at the moment. This can be partially achieved by enhanced expertise through intensive education and training of developers or information providers. They would then be capable of carrying out research to develop more sophisticated applications after such education, even with the limited source of raw data.

Another way to improve agrometeorological bulletins is to enhance the overall layout and design for better user-friendly interfaces with easily understandable formats. Many skills need to be elaborated for better weather observation, data retrieval, archiving, manipulation, management, analysis, hardcopy, publishing, etc.

Above all, good communication skill with end-users is an essential element that decides the applicability of information to farmers' decision making. Thus, any direct distributors of information to farmers should recognize the importance of communication skills with relevant strategies depending upon the level of end users to understand their requirements.

Various types of collaborations can be made to create a synergy effect among the agrometeorological bulletins and the related offices or institutes or organizations, domestically, regionally and globally. Sharing of resources from different offices can contribute greatly to the strengthening

of national agrometeorological services, for example, human resources with diverse expertise, hardware resources such as facilities and equipment, software resources, etc.

1) User recognition
   - Education /Training

2) Applications
   - Introduction/Modification/Implementation/Development

3) Resources
   - Experts
   - Training/Education
   - Tools
   - Upgrade
   - Skills
   - Elaboration

4) Communications
   - Technology (hardware, software) improvement
   - Skillful communications with end-users

5) Collaborations
   - Based on mutual benefit
   - Continuous collaboration

6) Operation
   - Sufficient manpower
   - Mechanical stability

Essential Subjects to be considered for better bulletins

1) Contents: Accessibility, Timeliness, Relevance and Accuracy
   - Quality – Specialization, Expertise, User-oriented, Appropriateness, Feasibility
   - Quantity – Diversity, Extended coverage, Detailed description
   - Standardization – format, lay-out, processes
   - Timeliness – Information (in advance or forecast-based), On-time delivery

- Efficiency – Automation of processes (drawing, coloring, editing, printing, etc.)

2) Tools: Easy, User-friendly, Cost-effective, Compatible and Standardized

- Statistical packages
- Image processing
- Presentation tools
- Analysis tools
- Simulation models
- Systems: Decision-Making Support System, Expert System
- GIS/RS Technology

3) Resources: Accessibility, Continuity, Sufficiency and Reusability

- Raw Data: Meteorological, Agricultural, Non-agricultural
- Expertise
- Computers
- Networks
- Interfaces
- Infrastructure
- Organization

4) Applications: Diversity, Differentiated, Applicability and Practicability

- Farm management
- Food security
- Market implications
- Early warning
- Risk management
- Resource management

5) Collaborations: Continuity, Cost/Benefit and Willingness

- Domestic
- Regional
- International

6) Communication: Accessibility, Cost Effectiveness, Performance and User-friendliness

- Information Network
- Interface
- Skills
- Feedback

7) System Operation: Performance, Relevance, Ease, and Cost Effectiveness

- Server
- Data-Base Management System (DBMS)

8) Processing/Manipulation/Preparation: Timeliness, Feasibility, Smoothness,

- Data>information>bulletin>on-site application

9) Economic Value/Benefits: Final decision on a new system will be made considering its economic value or the social benefits of its applications

10) Special Edition: Explanatory or evaluative descriptions on abnormal or extreme weather phenomena with their consequences or impacts on agriculture can be published in a special edition of the bulletin whenever needed.

Suggestions from Korea's case

This section introduces recent collaborative activities in agricultural weather information services among institutions as well as key concepts for understanding agrometeorological services in Korea. KMA (Korea Meteorological Administration, NMHS) and RDA (Rural Development Administration) agreed upon the establishment of the Joint Committee for Agrometeorology at the national level to strengthen the national agrometeorological services in data collection, information production, research, and services to end-users in 1999. Several joint projects in agrometeorology by RDA/KMA have been initiated since 1999. The projects being developed are:

- Strengthening of the Joint Committee of Agrometeorology
- Extension of observation network for agricultural weather
- Production of the detailed Agrometeorological information based on numerical weather forecasts

- Development of seasonal and inter-annual weather forecasts for agricultural applications, Information network system for supporting agrometeorological research
- Improvement of Agrometeorological information services at national and regional levels.

Strengthening of programs for the education and training of Agrometeorologists are impending priorities of the government. RDA and KMA play a major role in establishing the National Agrometeorological Center, through close collaboration with universities, scientific societies, and other relevant institutions. It is believed that advanced infrastructures and services in agrometeorology will be established in the next 5 years, which can contribute to regional and global societies by sharing experiences and the know-how expected to be gained from this achievement.