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Technological Approaches and Applications to Improve Agricultural Activities: A Review Study

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ABSTRACT

In this paper I have reviewed the agricultural technologies need applications of agricultural meteorology technology is increasingly gaining recognition as an important source of agro meteorological data as it can complement well the traditional methods agro meteorological data collection. Agro meteorologists all over the world are now able to take advantage of a wealth of observational data, product and services flowing from specially equipped and highly sophisticated environmental observation satellites. In addition, Geographic Information Systems (GIS) technology is becoming an essential tool for combining various map and satellite information sources in models that simulate the interactions of complex natural systems. The Commission for Agricultural Meteorology of WMO has been active in the area of remote sensing and GIS applications in agro meteorology. The paper provides a brief overview of the satellite remote sensing and GIS Applications in agricultural meteorology along with a description of the WMO Satellite Activities schedules.

KEY WORDS: GIS, Meteorology, AWS, ICT, GOS.

I. INTRODUCTION

Agricultural planning and use of agricultural technologies need application of agricultural meteorology. Agricultural weather and climate data systems are necessary to expedite generation of products, analyses and forecasts that affect agricultural cropping and management decisions, irrigation scheduling, commodity trading and markets, fire weather management and other preparedness for calamities, and ecosystem conservation and management. Agro meteorological station networks are designed to observe the data of meteorological and biological phenomena together with supplementary data as disasters and crop damages occur. The method of observation can be categorized into two major classes, manually observed and automatic weather stations (AWS). A third source for agro meteorological data that is gaining recognition for its complementary nature to the traditional methods is satellite remote sensing technology. Remotely sensed data and AWS systems provide in many ways an enhanced and very feasible alternative to manual observation with a very short time delay between data collection and transmission. In certain countries where only few stations are in operation as in Northern Turkmenistan, remotely sensed data can improve information on crop conditions for an early warning system. Due to the availability of new tools, such as Geographic Information Systems (GIS), management of an incredible quantity of data such as traditional digital maps, database, models etc., is now possible. The advantages are manifold and highly important, especially for the fast cross sector interactions and the production of synthetic and lucid information for decision-makers. Remote sensing provides the most important informative contribution to GIS, which furnishes basic informative layers in optimal time and space resolutions.

THE COMMISSION FOR AGRICULTURAL METEOROLOGY (CAGM) OF WMO, REMOTE SENSING AND GIS : Agricultural meteorology had always been an important component of the National Meteorological Services since their inception. A formal Commission for Agricultural Meteorology (CAgM) which was appointed in 1913 by the International Meteorological Organization (IMO), became the foundation of the CAgM under WMO in 1951.The WMO Agricultural Meteorology Programme is coordinated by CAgM. The Commission is responsible for matters relating to applications of meteorology to agricultural cropping systems, forestry, and agricultural land use and livestock management, taking into account meteorological and agricultural developments both in the scientific and practical fields and the development of agricultural meteorological services of Members by transfer of knowledge and methodology and by providing advice. CAgM recognized the potential of remote sensing applications in agricultural meteorology early in the 70s and at its sixth session in Washington in 1974 the Commission agreed that its programme should include studies on the application of remote sensing techniques to agro meteorological problems and decided to appoint a rapporteur to study the existing state of the knowledge of remote sensing techniques and to review its application to agro meteorological research and services.. The Commission at that time noted that there was a demand in almost all countries for a capability to use satellite imagery in practical problems of agro meteorology. The Commission continued to pay much attention to both remote sensing and GIS applications in agro meteorology in all its subsequent sessions up to the 13th session held in Ljubljana, Slovenia in 2002. Several useful publications including Technical Notes and CAgM Reports were published covering the use of remote sensing for obtaining agro meteorological information, operational remote sensing systems in agriculture, satellite applications to agro meteorology and technological developments for the period 1985-89 statements of guidance regarding how well satellite capabilities meet WMO user requirements in agro meteorology. At the session in Slovenia in 2002, the Commission convened an Expert Team on Techniques (including Technologies such as GIS and Remote Sensing) for Agro climatic Characterization and Sustainable Land Management.

MODERN GIS APPLICATIONS IN AGROMETEOROLOGY : A GIS generally refers to a description of the characteristics and tools used in the organization and management of geographical data. The term GIS is currently applied to computerized storage, processing and retrieval systems that have hardware and software specially designed to cope with geographically referenced spatial data and corresponding informative attribute. Spatial data are commonly in the form of layers that may depict topography or environmental elements. Nowadays, GIS technology is becoming an essential tool for combining various map and satellite information sources in models that simulate the interactions of complex natural systems. A GIS can be used to produce images, not just maps, but drawings, animations, and other cartographic products.
The increasing world population, coupled with the growing pressure on the land resources, necessitates the application of technologies such as GIS to help maintain a sustainable water and food supply according to the environmental potential. The “sustainable rural development” concept envisages an integrated management of landscape, where the exploitation of natural resources, including climate, plays a central role. In this context, agro meteorology can help reduce inputs, while in the framework of global change, it helps quantify the contribution of ecosystems and agriculture to carbon budget. Agro climatological analysis can improve the knowledge of existing problems allowing land planning and optimization of resource management. One of the most important agro climatological applications is the climatic risk evaluation corresponding to the possibility that certain meteorological events could happen, damaging crops or infrastructure.

ROLE SATELLITE REMOTE SENSING IN SPATIAL SYSTEM: Remote sensing provides spatial coverage by measurement of reflected and emitted electromagnetic radiation, across a wide range of wavebands, from the earth’s surface and surrounding atmosphere. The improvement in technical tools of meteorological observation, during the last twenty years, has created a favorable substratum for research and monitoring in many applications of sciences of great economic relevance, such as agriculture and forestry. Each waveband provides different information about the atmosphere and land surface: surface temperature, clouds, solar radiation, processes of photosynthesis and evaporation, which can affect the reflected and emitted radiation, detected by satellites. The challenge for research therefore is to develop new systems extracting this information from remotely sensed data, giving to the final users, near-real-time information. Over the last two decades, the development of space technology has led to a substantial increase in satellite earth observation systems. Simultaneously, the Information and Communication Technology (ICT) revolution has rendered increasingly effective the processing of data for specific uses and their instantaneous distribution on the World Wide Web (WWW).

The meteorological community and associated environmental disciplines such as climatology including global change, hydrology and oceanography all over the world are now able to take advantage of a wealth of observational data, products and services flowing from specially equipped and highly sophisticated environmental observation satellites. An environmental observation satellite is an artificial Earth satellite providing data on the Earth system and a Meteorological satellite is a type of environmental satellite providing meteorological observations. Several factors make environmental satellite data unique compared with data from other sources, and it is worthy to note a few of the most important:

- Because of its high vantage point and broad field of view, an environmental satellite can provide a regular supply of data from those areas of the globe yielding very few conventional observations;
- The atmosphere is broadly scanned from satellite altitude and enables large-scale environmental features to be seen in a single view;

- The ability of certain satellites to view a major portion of the atmosphere continually from space makes them particularly well suited for the monitoring and warning of short-lived meteorological phenomena;

SPATIAL SPACE PROGRAME OWNED BY WMO : The World Meteorological Organization, a specialized agency of the United Nations, has a membership of 187 states and territories. Amongst the many programs and activities of the organization, there are three areas which are particularly pertinent to the satellite activities:

- To facilitate world-wide cooperation in the establishment of networks for making meteorological, as well as hydrological and other geophysical observations and centres to provide meteorological services;
- To promote the establishment and maintenance of systems for the rapid exchange of meteorological and related information;
- To promote the standardization of meteorological observations and ensure the uniform publication of observations and statistics.

The Fourteenth WMO Congress, held in May 2003, initiated a new Major Programme, the WMO Space Programme, as a cross-cutting programme to increase the effectiveness and contributions from satellite systems to WMO Programs. Congress recognized the critical importance for data, products and services provided by the World Weather Watch's (WWW) expanded space based component of the Global Observing System (GOS) to WMO Programs and supported Programs. During the past four years, the use by WMO Members of satellite data, products and services has experienced tremendous growth to the benefit of almost all WMO Programs and supported Programs. The decision by the fifty-third Executive Council to expand the space-based component of the Global Observing System to include appropriate R&D environmental satellite missions was a landmark decision in the history of WWW. Congress agreed that the Commission for Basic Systems (CBS) should continue the lead role in full consultation with the other technical commissions for the new WMO Space Programme. Congress also decided to establish WMO Consultative Meetings on High-level Policy on Satellite Matters. The Consultative Meetings will provide advice and guidance on policy-related matters and maintain a high level overview of the WMO Space Programme. The expected benefits from the new WMO Space Programme include an increasing contribution to the development of the WWW's GOS, as well as to the other WMO-supported programs and associated observing systems through the provision of continuously improved data, products and services, from both operational and R&D satellites, and to facilitate and promote their wider availability and meaningful utilization around the globe.

THE WMO SPACE PROGRAME LONG-TERM STRATEGY IS: "To make an increasing contribution to the development of the WWW's GOS, as well as to the other WMO-supported Programs and associated observing systems (such as AREP's GAW, GCOS, WCRP, HWR's WHYCOS and JCOMM's implementation of GOS) through the provision of continuously improved data, products and services, from both operational and R&D satellites, and to facilitate and promote their wider availability and meaningful utilization around the globe".

The main elements of the WMO Space Programme Long-term Strategy are as follows:

- Increased involvement of space agencies contributing, or with the potential to contribute to, the space-based component of the GOS;
- Promotion of a wider awareness of the availability and utilization of data, products - and their importance at levels 1, 2, 3 or 4 - and services, including those from R&D satellites

COORDINATION GROUP FOR METEOROLOGICAL SATELLITES (CGMS) : In 1992 a group of satellite operators formed the Co-ordination of Geostationary Meteorological Satellites (CGMS) that would be expanded in the early 1999s to include polar-orbiting satellites and changed its name but not its abbreviation - to the Co-ordination Group for Meteorological Satellites. The Co-ordination Group for Meteorological Satellites (CGMS) provides a forum for the exchange of technical information on geostationary and polar orbiting meteorological satellite systems, such as reporting on current meteorological satellite status and future plans, telecommunication matters, operations, inter-calibration of sensors, processing algorithms, products and their validation, data transmission formats and future data transmission standards.Since 1992, the CGMS has provided a forum in which the satellite operators have studied jointly with the WMO technical operational aspects of the global network, so as to ensure maximum efficiency and usefulness through proper coordination in the design of the satellites and in the procedures for data acquisition and dissemination.

II. CONCLUSIONS AND FUTURE SCOPES

Recent developments in remote sensing and GIS hold much promise to enhance integrated management of all available information and the extraction of desired information to promote sustainable agriculture and development. Active promotion of the use of remote sensing and GIS in the National Meteorological and

Hydrological Services (NMHSs), could enhance improved agro meteorological applications. To this end it is important to reinforce training in these new fields. The promotion of new specialized software should make the applications of the various devices easier, bearing in mind the possible combination of several types of inputs such as data coming from standard networks, radar and satellites, meteorological and climatological models, digital cartography and crop models based on the scientific acquisition of the last twenty years. International cooperation is crucial to promote the much needed applications in the developing countries and the WMO Space Programme actively promotes such cooperation throughout all WMO Programs and provides guidance to these and other multi-sponsored programs on the potential of remote sensing techniques in meteorology, hydrology and related disciplines, as well as in their applications. The new WMO Space Programme will further enhance both external and internal coordination necessary to maximize the exploitation of the space-based component of the GOS to provide valuable satellite data, products and services to WMO Members towards meeting observational data requirements for WMO programs more so than ever before in the history of the World Weather Watch.

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