Meteorological Information System 'Metis' in the Context of Rural Areas of Chhattisgarh (India)

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ABSTRACT

Agriculture-meteorological advisory (in Hindi) of villages, in the remote places of India is a pre-requisite. Thus an application of the Computer Science has been developed named as meteorological information system (MetIS) is developed for agricultural land use planning for villages of Bilaspur, Chhattisgarh. The system is to provide a land use planning advisory of the village as well as meteorological advisory for best possibilities via Internet and web technology is presented through this paper.

Keywords: Agriculture, Meteorological, forecasting, System, Soil, Information System, Broadcasting, SoS, BSNL.

1. INTRODUCTION

Chhattisgarh state is a unique one state in India famous for cultivation of rice (paddy). It occupies an area of 14 M ha. The state is predominately an agrarian one. The state has 21 districts, ten high-resolution geographic regions and each one having great complexity in occurrence of weather and soils therein [1, 2]. State is geographically situated in latitude of $17^0$46' N to $24^0$5'N, longitude of $80^0$15' E to $84^0$20' E as shown in Fig 1.

Fig. 1. Location of Chhattisgarh in India
IMD Pune, Kalpana-I image, Sector Color Composite of INDIA
http://www.imd.gov.in/section/satmet/dynamic/insatsector-irc.htm

To provide agriculture-meteorological advisories of very small-scale geographical regions (viz., village, tahasil/block, district, and whole subdivision) in the remote places of India, a distributed and web based (over the BSNL network) agriculture meteorological information system of system (SoS) named 'MetIS' has been developed, intended for sustainable agricultural development and planning in rural area. The SoS is used to transfer land features, land interpretative groupings and land use planning as well as soil suitability meteorological information such as July rainfall, annual and seasonal monsoon rainfall, temperature, soil moisture, sea level pressure, station level pressure, vapor pressure etc. as well as issuing long-range meteorological data predicted information over the remote places. 1:250,000 scale field traversing, remote sensing, and cartography data have been used to identify soil characteristics. Sixty-one years (1951-2004) meteorological data have been used to process meteorological information. Six components of data warehousing and mining technique have been applied to retrieve data. Three-layer perception feed forward back propagation parametric and deterministic artificial neural network models have been developed to predict long-range meteorological data prediction over the remote places, and remote method invocation techniques have been used to develop client server based architecture of the system. The system has been developed and tested is presented in this article.

The evaluation of agriculture meteorology is a pre-requisite for any agricultural development and planning. And it is needed to be popularized for creating awareness among the land users, planners, research workers and administrators in order to ensure the proper effective utilization of agriculture meteorological resources so that it can be conserved, preserved and handed over in its natural habitat to the next generations. Intended for this, a client-server based satellite communication network system with transaction data remote server facility has been proposed in which client machines have to be situated at the remote places especially villages and tahasil of a particular district though under the control of server situated on nodal office named as MetIS. It is used to communicate geostationary satellite, to broadcast data to the agriculture community. In fact, the system has been developed to meet the following three vital objectives.

1. Provide information to the farming community or planners regarding farming village, in terms of land features (geology, physiography, slope, soil erosion, soil drainage), soils (soil classification, depth, texture (surface), AWHC, pH, salinity and sodicity, CEC, organic carbon status, particle size, clay mineralogy, calcareousness, stoniness, NKP, $CaCO_3$), interpretative groupings (land capacity classification, irrigability classification, quality, degradation, problem soil, length of growing period, agro-ecological units, production potential), and land use planning, soil suitability (arable: paddy, teora, jowar, maize, musterd, groundnut, urid, minormillets, wheat, gram, sugarcane, linseed, vegetables, fruit crops, non-arable- teak, bamboo, nilgiri, sal, mixed forest).

2. Forecast long-range monsoon rainfall over the fifteen districts as well as whole sub-divisions of Chhattisgarh and issue necessary advisories.

3. An efficient use of natural resources, causing minimal damage and disturbance to the environment.

2. SOIL DATA

Soil data are collected from NBSS&LUP Nagpur. Soil resource mapping of Chhattisgarh state was carried out by NBSS&LUP using RS and field traversing accompanied by laboratory analysis and cartography [1, 2]. Soil families association map on 1:250,000 scale have been collected from NBSS&LUP and used for the system development. Landsat imagery are interpreted for landform analysis and then the result was superimposed on topobase by incorporating the geomorphic boundaries which were further delineated by natural boundaries, sub regions, based on geological variations and units based on landform sequence. The fieldwork was conducted on 1:50,000 scale. Each topobase covers an area about 1.15 M ha. It is marked with grids and strips. There are 110-130 grids, i.e., 10×10 Km interval and 8-10 strip each of 50 sq. Km having 25-30 observation/strip each on topobase. In all, there are 1340 grids, 240 random observations (10-20 observations/topobase of area not covered in strip/grid or extensive or problematic/or special nature). The total number of soil samples for laboratory characterization used by NBSS & LUP was 6,650.

IMD data stations of Chhattisgarh with maximum meteorological data (1951-2004) availability have been collected. Missing years of data (less then 10%) are replaced by neighboring (within 2 km) raingauge station data. Even after this replacement, monthly rainfall values for few stations and for few years were missing and these were replaced by their monthly mean values. The station averages are calculated only up to the stations level. Consequently meteorological data series constructed is homogeneous as well as temporally. In addition, $2.5^0\times2.5^0$ lat., and long. Meteorological RS data from NOAA USA have been collected for the system development.

3. COMPUTER NETWORK IN RURAL AREA OF CHHATTISGARH

Since MetIS architecture is based on client server based protocol, it becomes very important to access the server in which database and programs are hosted. In general there are two ways to access the remote servers on basis of data volume requirement and confidentiality needs from rural areas.

1. Using LAN /WAN topology using leased line network which is used to provide point to point connectivity between any two computers/networks using dedicated physical logical

connections. Due to recent advancement of technology MPLS VPN Networks may also be used. However this approach can be used in case when information mining is to be done on continuous basis, which in this case can be done by an organization supporting the rural planner/farmers in deciding on the land use and planning. As cheaper alternative VPNoBB or CDMA based VPN can also be used.

2. In case of small planners/farmers who want to use individual mining of information on land use planning, there are various means for accessing the URL address used for MetIS through Internet access these are described as Dial Up connection, ISDN Network, Broadband Network, GPRS, Blackberry and EVDO/NIC Data Card, WIMAX Technology.

4. METIS

MetIS has been developed in two versions one based on distributed network and second based on Web. For distributed version, RMI technology over the TCP/IP protocol has been used to create network skeleton. And for web version, Servlet technology over HTTP protocol has been used to create network skeleton. Six components have been used to develop the MetIS (for both the version) are shown in Fig. 2. It is to be implemented over the VSAT or BSNL communication network to broadcast agriculture meteorological information to the rural places, i.e., villages. It is basically a SoS wherein; two separate systems, i.e., Data Warehousing and Mining based Soil Information System (DWMSIS) and ANN based Meteorological Parameter Forecasting System (ANNMPFS) have been implemented and embedded into the system server logic to obtain above three objectives. Both the systems are individually performed and interconnected. The SoS is shown in Fig. 2 and Fig. 3 (a and b). The overview of BSNL network for rural Chhattisgarh is discussed in following section.

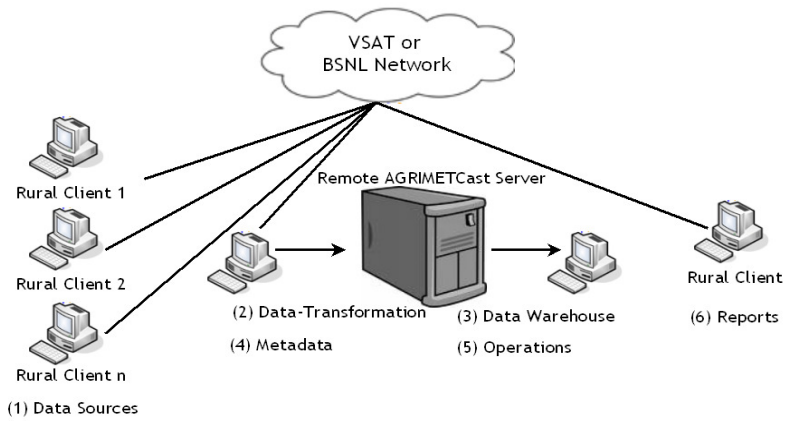
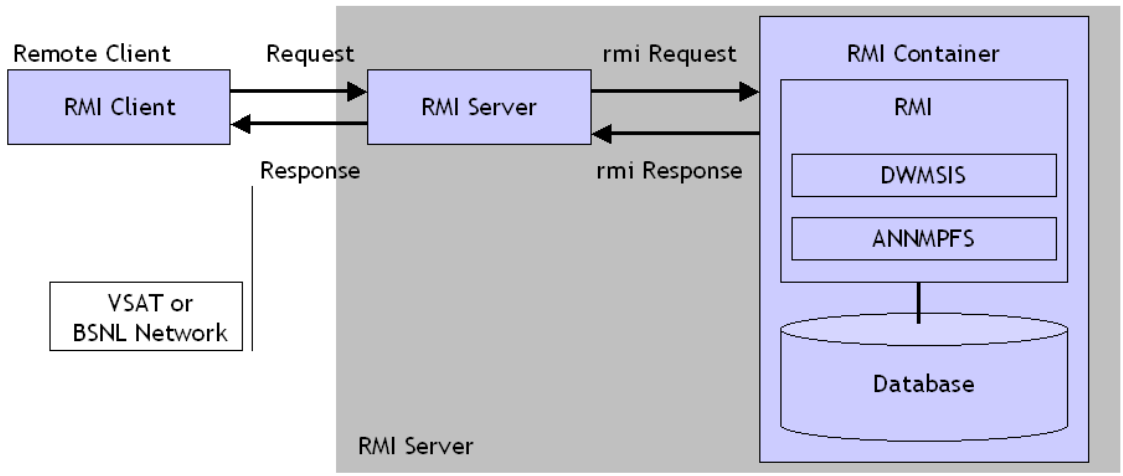
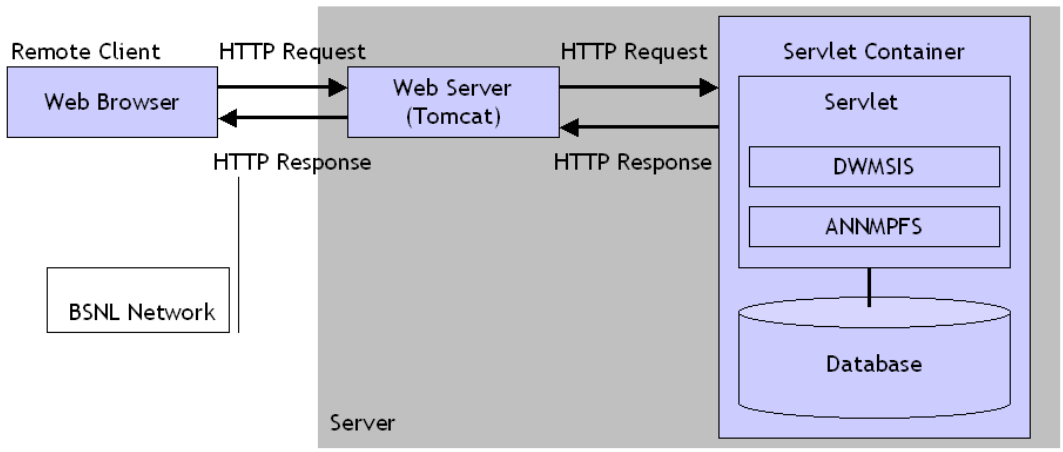


Fig. 2. MetIS via VSAT or BSNL Network



(a)



(b)

Fig. 3. SoS MetIS with Two Interconnected System, i.e., DWMSIS and ANNMPFS, (a) For Distributed Version (b) For Web Version.

4.1. DWMSIS

To acquire first objective, DWMSIS system has been developed. In this system user may select particular village and can acquire entire information related with the soil and meteorological parameters with the expert decisions regarding the land use planning for sustainable agricultural development (third objective). The DWM technique is used for the expansion of the system database that collects, integrates and stores entire state soil and meteorological data related to yield

prediction data with the aim of producing accurate and timely management of information. As result of OOD, six consistent components of system are described as follows:

Component 1: Data Sources

Data sources refer to any client machine's data that sends soil, meteorological data, and other related data of district/tahasil. Microsoft SQL Server is used to develop database. Data needs to be passed from either server or client systems to the data warehouse either on a transaction-by-transaction basis for real-time data warehouses or on a regular cycle (e.g. daily or weekly) for offline data warehouses.

Component 2:Data-Transformation

The Data Transformation component used to receive data from the data sources (client machines), cleans and standardizes it, and loads it into the data warehouse.

Component 3: Data Warehouse

Relational Data Base Management System (RDBMS) is used to develop warehousing.

Component 4: Metadata

In this component various soil characteristics, soil tables, column name, and their detailed description have been included.

Component 5: Operations

This component is used to comprise the processes of loading, manipulating and removing data from the data warehouse. Operations also cover DBA, security, capacity management and associated functions.

Component 6: Reports

Relational data mining technique in the DWMSIS through SQL and complex if…else statements have been implemented to generate report for the users (agriculture planners and experts).

4.2. ANNMPFS

To accrue second objective, i.e., forecast long-range monsoon rainfall over the districts as well sub-divisions as a whole of Chhattisgarh and issue necessary advisories ANNMPFS has been developed [3-12].

5. RESULTS AND DISCUSSIONS

In MetIS, two interconnected individual systems, i.e., DWMSIS, and ANNMPFS are implemented. Proposed objectives are achieved by both the systems. The SoS tested in local network successfully

and ready to implement for remote places of the district via VSAT or BSNL communication network. User Interfaces (inputs, outputs and reports) of MetIS in Distributed Version as well as Web Version are shown in Fig 4 (a, b) and Fig 5 (a, b) respectively.

6. CONCLUSIONS

MetIS in the context of remote places of Chhattisgarh has been developed for sutainable development of agriculture in rural areas of Chhattisgarh. Through this SoS a user (viz., agriculture planners, administrators, farmers, researchers) may obtain suggestions regarding soil characteristics at village level, district level meteorological parameters (viz., monsoon rainfall, annual rainfall, temperature, soil surface temperature, station level pressure, sea level pressure, vapour pressure, cloud covers, etc.) along with its long-range forecasted advisory. Soil families association map on 1:250,000 scales RS data have been collected from NBSS&LUP Nagpur, and used for the system soil database development. Artificial neural network technique (results of present research) has been employed to forecast meteorological parameters in which 61 years′ data have been used. The SoS also has been developed for land use planning, i.e., arable and non-arable uses at village level. It is used to identify best possibilities of agriculture planning and development. Moreover, system has a longer lead-time as they can be made an year in advance. Thus the system developed is an innovative one to meet the three objectives for the districts or villages accurately.

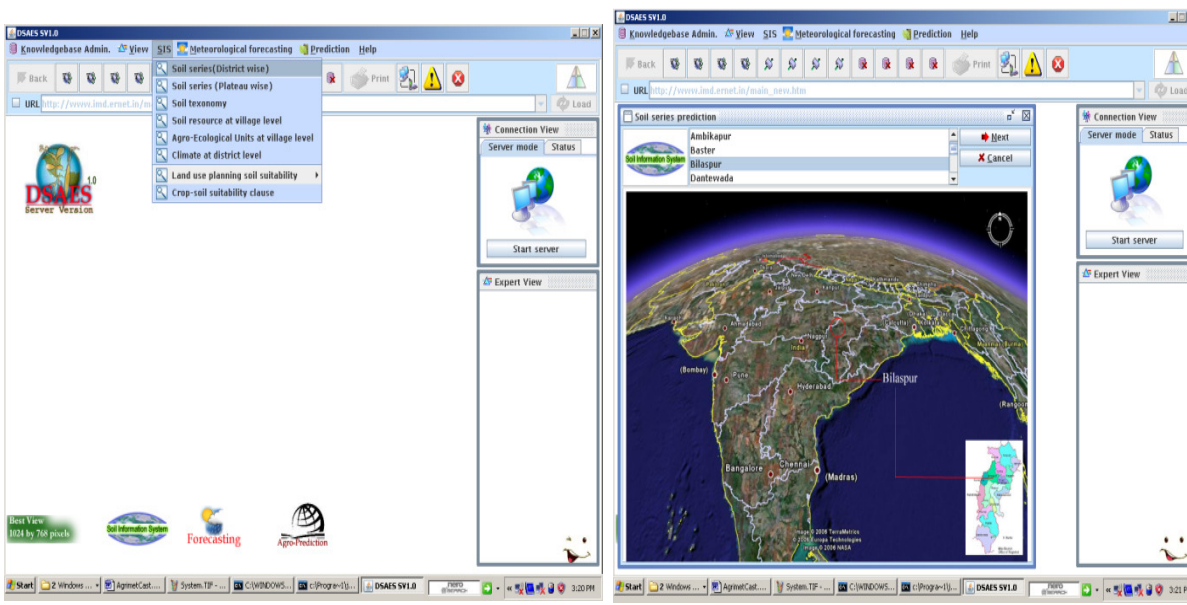


Fig. 4 (a, b). User Interface of MetIS (Distributed Version)

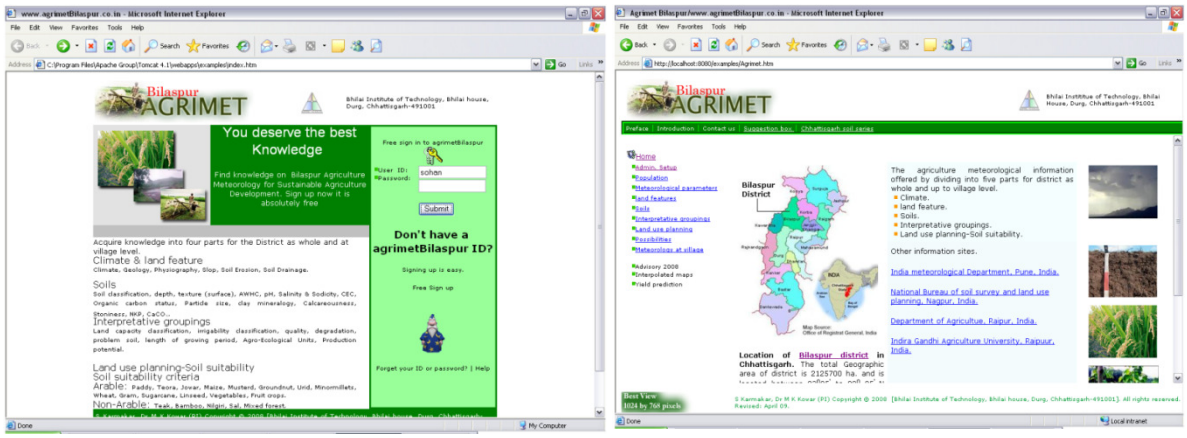


Fig. 5 (a, b). User Interface of MetIS (Web Version)

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