DEPLOYMENT OF AUTOMATIC WEATHER STATION FOR VILLAGE INFORMATION SYSTEMS OVER KADAPA AND NELLORE

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***Abstract*— Villages are the backbone of India economy. In planning and development process village should be at the centre. Village information system (VIS) is a micro level study which may helpful to planners, policy makers and administrators in planning and decision making process. It is seen that may planning gets fail due to insufficient and non availability of data. The main objective of this study is to provide weather dissemination, operation, maintenance, sustainable development and modernization of 19-"Village Information Systems" (VIS) operational over Kadapa and Nellore districts. One of the important objectives of this pilot project is to provide location specific information to farmers, fishermen (Nellore), rural women, students and children on agriculture, irrigation, education, nutrition, healthcare vocation etc. Using these facilities, the volunteers are able to create query, print personal documents, weather data and important agricultural interactive maps for the benefit of villagers. Two Automatic Weather Stations (AWS) are installed to monitor two (wet over Nellore and dry over Kadapa region) divergent climatic zones in a very close range of about 150 km with distinctive and varying weather characteristics such as temperature, humidity, pressure, rainfall and etc. A study has been made to calibrate, evaluate and assess the performance of two AWS. In addition, we are disseminating meteorological forecast data to the VIS through e-mail and severe weather information through SMS.**

***Index Terms*— Village Information System, AWS, Meteorological Parameters, Calibration and Validation**

I. INTRODUCTION (HEADING 1)

Village information system (VIS) is a micro level study which may helpful to planners, policy makers and administrators in planning and decision making process. It is seen that may planning gets fail due to insufficient and non availability of data. Data is considered as raw material from which meaningful results and analysis can be carried out. Database is a group of organized records and files which are stored systematically and shared by different users. To generate an information system it requires a lot of data [1]. Development is a process of improving the lives of people in equitable, just and sustainable manner. It involves efficient planning, effective monitoring and knowledge based decision making. Weather is a vital factor to the success of agriculture, research and education, routine life, and many other activities around the world. To increase the productivity of farming, it is essential to know the light, temperature, moisture, sunshine, radiation level, rainfall and other conditions. The data is deemed essential as solar radiation and temperature have a direct impact on ambient humidity and affects the quality of crop, so measurements of these conditions are crucial. Considering the emerging requirement of the society under dynamical changing climatic conditions reliable weather forecast is inevitable. For agricultural needs agro-meteorological data is required for good yield of food grains during Kharif and Rabi seasons. For every day divergent weather conditions in dry and wet regions like Kadapa and Nellore district collection of 1-min data of temperature, pressure, humidity, wind speed wind direction and rainfall is required.

Village Information Systems (VIS) project was sponsored by Natural Resources Data Management Systems (NRDMS) Division of Department of Science & Technology (DST), Govt. of India during the year 2006 and was executed and installed by APCOST in association with Andhra Pradesh State Remote Sensing Applications Centre (APSRAC), Hyderabad. As a pilot project in Andhra Pradesh, we have chosen two divergent climatic zones Nellore (wet) and Kadapa (dry) in a very close range of about 150 km with distinctive and varying weather characteristics such as temperature, humidity, pressure, rainfall etc. 19-Village Information Systems (VIS) [9 in Nellore and 10 in Kadapa districts of Andhra Pradesh, India] shown in fig. 1 are established to understand semi- arid and coastal region weather systems and also provide micro-level digital information on Natural Resources, Socio-Economic and Infrastructure Facilities (Health, Education, etc.,), Crop Suitability, Market Facilities, etc., to common citizen. The two regions were selected because they represent the two divergent climatic zones i.e. savanna and semi-arid. In addition, every day, we disseminate meteorological forecast data to the VIS through e-mail/SMS.

(a) NELLORE (District)

Sl. No	LOCATION OF VIS KIOSK(lat, long)	MANDAL
1.	Venkanapalem (14°29.92′, 80°9.42′)	Indukurupeta
2.	Mypadu (14°30.36′, 80°10.36′)	Indukurupeta
3.	Gangapatnam (14°31.55′, 80°10.40′)	Indukurupeta
4.	Kudithipalem (14°34.14′, 80°11.21′)	Indukurupeta
5.	Utukuru (14°34.63′, 80°8.78′)	Vidavaluru
6.	Dandigunta (14°38.12′, 80°8.63′)	Vidavaluru
7.	East Gogulapalli (14°42.14′, 80°6.35′)	Allur
8.	Iskapalle (14°44.28′, 80°7.13′)	Allur
9.	Juvvaladinne (14°45.02′, 80°4.95′)	Bogole

(b) KADAPA (District)

Sl. No	LOCATION OF VIS KIOSK(lat, long)	MANDAL
1.	Kamasamudram (14°35.3′, 78°6.3′))	Lingala
2.	Bhadrampalle (14°36.05′, 78°15.13′)	Thondur
3.	Tonduru (14°34.7′, 78°17.5′)	Thondur
4.	Inagaluru (14°33.17′, 78°16.15′)	Thondur
5.	Telluru (14°31.47′, 78°15.58′)	Thondur
6.	Maduru (14°31.15′, 78°13.73′)	Thondur
7.	Saidapuram (14°31.1′, 78°15.6)	Thondur
8.	Ankalammaguduru (14°34.54′, 78°11.05′)	Simhadripuram
9.	Lomada (14°33.8′, 78°15.5′)	Simhadripuram
10	Balpanuru (14°32.22′, 78°12.00′)	Simhadripuram

Fig.1: Location of Village information systems over Nellore and Kadapa districts.

II. Methodology And Instrumentation

An Automated Weather Station (AWS) is an instrument that measures and records meteorological parameters using sensors without intervention of humans. The measured parameters can be stored in a built-in data logger or can be transmitted to a remote location via a communication link. If the data is stored in a data logger, recorded data must be physically downloaded to a computer at a later time for further processing [2-3]. Therefore, the communication system is an essential element in an automated weather station. Today, automated weather stations are available as commercial products with variety of facilities and options [4-6].

We have purchased two prototypes; low-cost Automatic Weather stations (AWS) DAVIS Vantage Pro2 Plus. The Automatic Weather Stations (AWS) shown in fig.2 collects 1-min air temperature (AT), atmospheric pressure (P), relative humidity (RH), wind direction (WD), wind speed (WS), Heat Index and rain fall (RF) round the clock. The weather parameter data were stored in a data logger [7-9]. The data acquisition rate could be programmed in the data logger. For the present study the data logger was programmed for collecting data every 1 minute. Each sample taken at 1 minute interval is an average of all samples taken at 10 seconds interval. The data is stored in the memory of the data logger and also simultaneously in to a Village Information System (VIS) kiosk also.

AWS include an integral radiation shield (Stephenson screen) as standard so that air temperature readings can be made with good accuracy. There is also the option of specifying one of two fan-aspirated shields (FARS) for ultimate temperature accuracy: a special FARS shield that runs continuously; or a lower-cost, daytime-only FARS shield that is powered solely by a solar panel and which is available as a separate add-on kit suitable for upgrading a standard VP shield at any time. The other calculated parameters are Dew Point, Wind Run, Wind Chill, Heat Index, THW Index, Rain Rate, Heat – DD, Cool – DD and Evapotransportation. For improved accuracy, temperature and humidity sensors are housed inside a radiation shield. The shield protects against solar radiation and other sources of radiated and reflected heat. These weather stations are installed on a rooftop over a galvanized mast. The AWS sensors are connected to the computer via cable for retrieving the meteorological data.

The AWS can be powered 3C alkaline batteries AC-DC adapter Solar Power kit consisting of solar panel, 6V SMF battery.

The Automatic Weather Station consist the following parts:

1. ISS (Integrated Sensor Suite) consisting of following sensors and parts
   - Air Temperature and Humidity sensor (Enclosed in a radiation Shield)
   - Anemometer (Wind Speed and Direction Sensor)
   - Rain Collector (Tipping bucket type Rain gauge)
   - Solar Radiation Sensor
   - UV Sensor
2. Console Receiver
   - Inside Temperature Sensor
   - Inside Humidity Sensor
   - Barometric Pressure Sensor
3. AC-DC Power Supply

The Mounting Tripod / Mast is a lightweight of 2 -3 meters height. Mast makes installation even easier. Brackets at the base of legs tilt to mount on roof or uneven terrain. Made of galvanized steel, the mast can be grouted in a concrete structure.

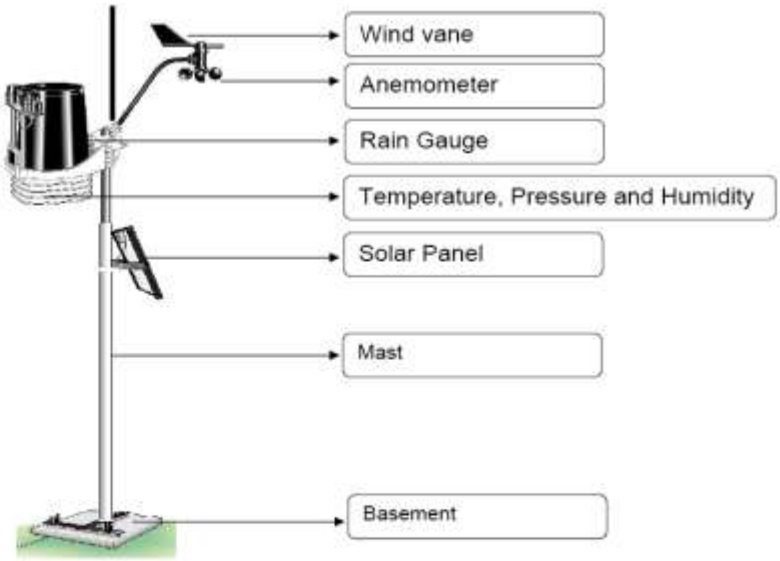


Fig.2: Schematic of the Automatic Weather Station installed at Inagalur, Kadapa District and Mypad, Nellore district.

Console Receiver

The Console receiver shown in figure 3 receives the data from the Integrated Sensor Suite. The Cabled Console is placed on a table near to VIS kiosk. A small data logger (Weather link data logger) fits inside the console that records the weather data at a user selectable archive interval. The Weather link data logger also has a interface that connects to the computer for further retrieval of data for analysis and record.

Data Communication

If the station is placed/installed at a remote place, then the data can be retrieved by various communication options such as PSTN (Telephone line) or a GSM Modem (Mobile Service). In this case Mobile service or a Telephone line should be available at the remote site. Communication of data is done through a modem via Telephone lines. A V 90 Modem and a Telephone adapter are installed for transferring the data from remote station to the central station/receive station.

The central station/receive station is configured with the telephone numbers of a standalone weather station or a network of weather stations such as STATION #1, STATION #2, STATION#3 so on. The computer with the weather link software will automatically dial to the remote station at a user selectable interval to collect the data. The data can be collected from the remote stations on hourly basis, six hours, 12 hours or any user selectable option. The modem can be powered at remote sites by AC power (if available) or a 12 V Battery. The battery can be recharged by a solar panel. The modem, battery and electronics are placed in a weather proof enclosure so as to protect it from hash weather conditions and vandalism.

Data logging to a personal computer

Reading weather data from the weather station console represents a major advance on manual measurements, but linking the station to a PC via the Davis Weather link data logging option adds a completely new dimension to making the most of our weather observations. Data logging opens the door to many sophisticated approaches to analyzing and presenting the weather data in impressive graphic form, but the experienced weather observer may be especially interested in three features:

A permanent and fully detailed record of all observed weather data can be maintained, with observations every 1 minute throughout every single day. Using the powerful graphing and presentation tools in the software as shown in figure 4, data from a particular day potentially some years back can be called up and viewed in detail. The Weather link software has a number of Report utilities that can automatically create monthly and yearly summaries of data, including highs and lows and other statistics. Using the Weatherlink software one can see current conditions at a glance on the instant weather bulletin, Graph data on a daily, weekly, monthly, or yearly basis, Generate Weather Watcher reports in international data [National Climatic Data Center (NOAA)] format. Track information from multiple weather stations on the same computer using one WeatherLink for each weather station and view information from the same weather station on two or more computers using an Extra User License for each computer.

Fig 3: Console Receiver of the Automatic Weather Station

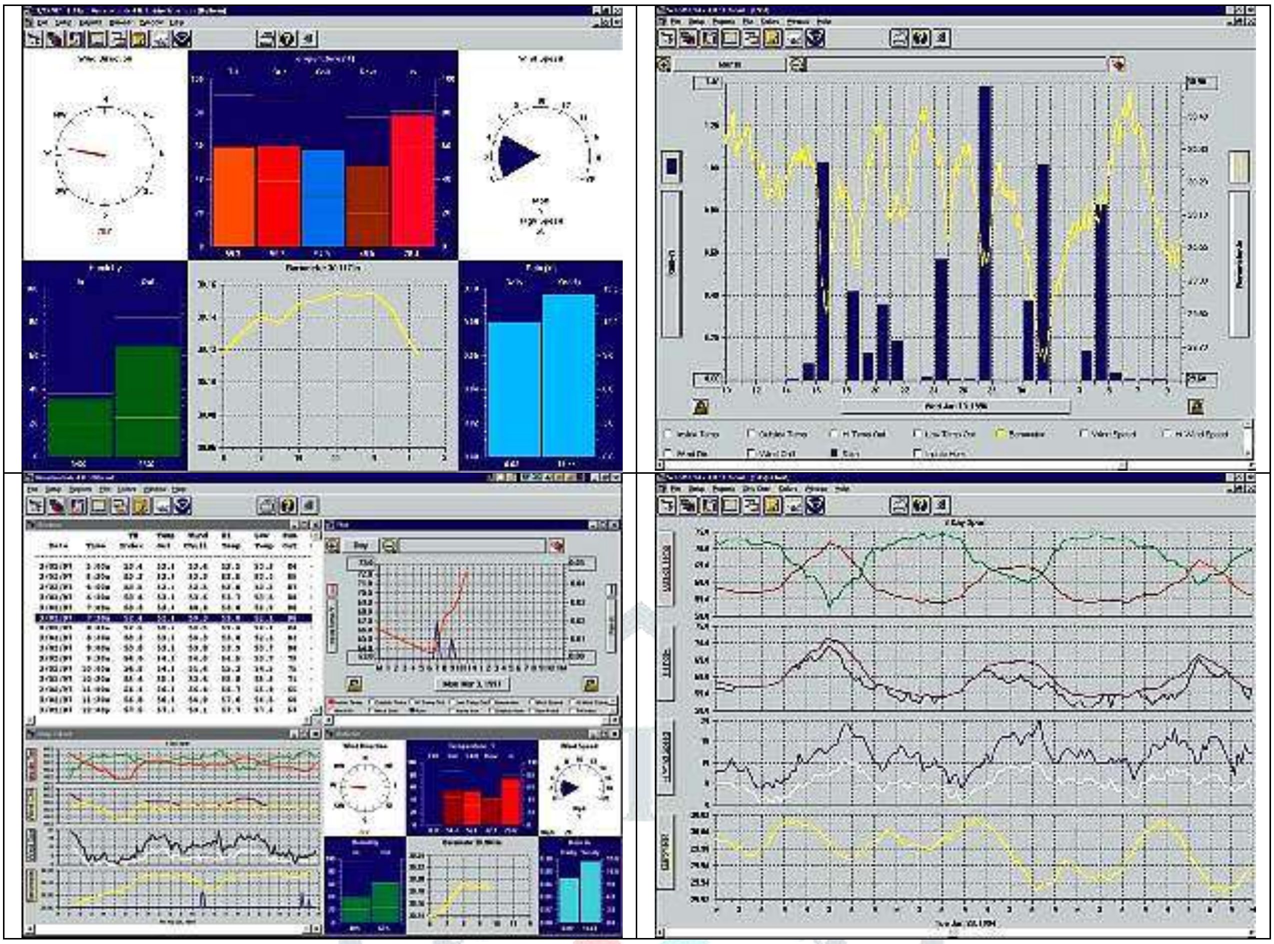


Fig 4: Weather link Software generated several meteorological parameters.

AWS have a number of advantages over conventional manual recording/India Climatic Station. AWS are more consistent in their measurement. They provide data at a significantly greater frequency in all weather, day and night, 365 days per year and can be installed in sparsely populated areas. Routine daily maintenance chores (eg emptying the rain gauge) are no longer necessary; AWS stations can automatically record and store maximum and minimum values for a range of weather parameters through each day and keep track of total monthly and yearly rainfall; However, AWS suffer a number of disadvantages like AWS require a large capital investment.

III. Topography, Climatology And Location Of Village Information Systems

Two divergent (wet and dry) climatic zones are available in Andhra Pradesh in a very close range of about 150 km with a distinctive and varying weather characteristics such as temperature, humidity, pressure, rainfall etc. The districts of Nellore and Kadapa possess these peculiar conditions and hence, 19-Village Information Systems (VIS) are established to understand semi- arid and coastal region weather systems and also provide micro-level digital information on Natural Resources, Socio-Economic and Infrastructure Facilities (Health, Education, etc.,), Crop Suitability, Market Facilities, etc., to common citizen[10-12]. Two AWS were installed at Mypad, Indukurupeta Mandal, Nellore District and at Inagaluru, Thondur Mandal, Kadapa District as shown in figure 5.

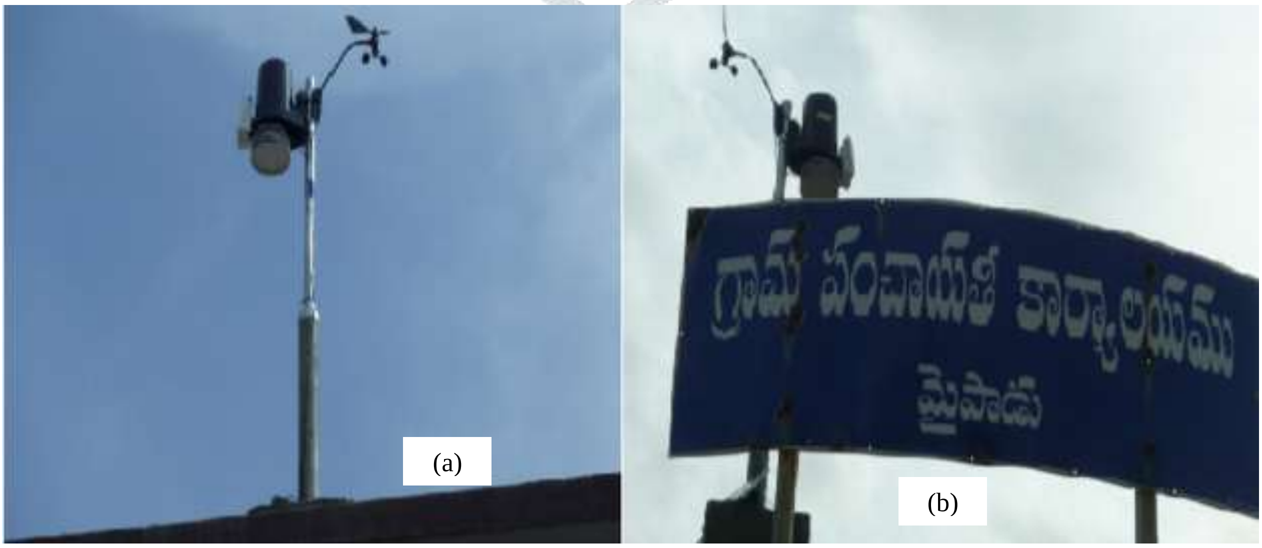


Figure 5: (a) AWS at Inagaluru (14˚33.17N, 78˚16.15E), ThondurMandal, YSR (Kadapa) Dist (b) AWS at Mypadu (14˚30.36N, 80˚10.36E), Indukurupeta, Sri Potti Sriramulu Nellore District

The Nellore district lies between 13°30' and 15°06' of Northern latitude and 70°05' and 80°15' of Eastern latitude. Nellore's total land area is 13,076 square kilometers (8,761) sq. miles. It is bordered by the Bay of Bengal to the east, the state of Tamil Nadu to the South, the district of Kadapa, and the district of Prakasam to the north. The eastern side consists of area of low lying land extending from the base of the Eastern Ghats to the sea. The west side of the district is separated from Kadapa district by Veligonda hills. The district is split by the River Pennar and is located on both south and north banks of it. The district is broadly divided in to 2 natural divisions from North to South. The eastern Half of the District adjoins coastal belt is fairly fertile and the western half of the district has low elevation towards west with large track of low shrub jungles diversified with rocky will stony plains.

Geographically, YSR (formerly known as Cuddapah and Kadapa) district is situated within 13°43' and 15°14' of the northern latitude and 77°55' & 79°29' of the eastern longitude. The district spreads northwards beneath the Western slopes of the Eastern Ghats mountain range as a rough parallelogram, dented deeply in its Southern, Western and Northern boundaries. It is surrounded by Kurnool district on the North, Chittoor district on the South, Nellore district and Prakasam district on the East and Anantapur District on the West. The total geographical area of the Kadapa district is 15,379 sq. Kms. The climate around Andhra Pradesh is warm, humid, or hot according to the season and the location of the area. The climate in Kadapa and Nellore is outlined in Table 1. The seasons are classified as pre-monsoon (March, April and May), monsoon (June, July, August and September), post-monsoon (October and November) and winter (December, January and February). Kadapa and Nellore receives rainfall from the SW monsoon as well as the NE monsoon. The SW monsoon begins from June and lasts till September, while the NE monsoon occurs in late October-early December. This region receives heavy rains during the NE monsoon also and subject to cyclonic conditions, which cause enormous damages to residential accommodation and standing crops. Note that in January to April, a dry season at Nellore and Kadapa, there is little rain.

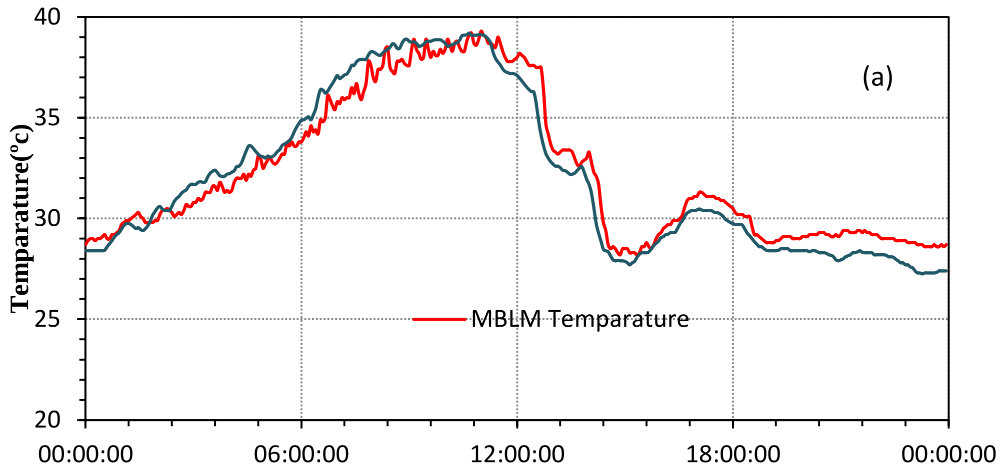
TABLE 1: CLIMATE AT KADAPA AND NELLORE

Climate	Month
Pre-monsoon	March, April and May
Summer/South-West monsoon	June, July, August and September
Post- /North-East monsoon	October, November and early December
Winter	Late December, January and February

IV CALIBRATION OF AWS AND VALIDATION OF METEOROLOGICAL PARAMETERS

We have temporarily installed two AWS at Yogi Vemana University weather observatory for Calibration and validation of meteorological data products. The YVU meteorological field station is having Indian Space Research organization (ISRO) -AWS, India Meteorological Department (IMD) Climatic Station, 15-Mini-Boundary Layer Mast (MBLM), GPS sonde, Disdrometer, Micro rain radar and lightning sensor. Hence, the Quality Assurance of Automatic Weather Station data are becoming more important and also introduction of new sophisticated sensors and processing algorithms[13-15].

We made an experiment on Automatic Weather Station (AWS) using Mini-Boundary Layer Mast (MBLM) observations. The main aim of the experiment is to evaluate the performance of the Automatic Weather Station (AWS) and data quality/reliability. From figures 6 and 7, a reasonable good time series correlation is noticed from the diurnal variation of temperature and relative humidity observations on clear sunny day (20 April 2009) and passage of thunderstorm clouds (22 April 2009). From the time series data it is found that the both instruments data evolution is more or less the same. It indicates to use Automatic Weather Station (AWS) for VIS to obtain key meteorological parameters during natural disasters such as Cyclones and drought.



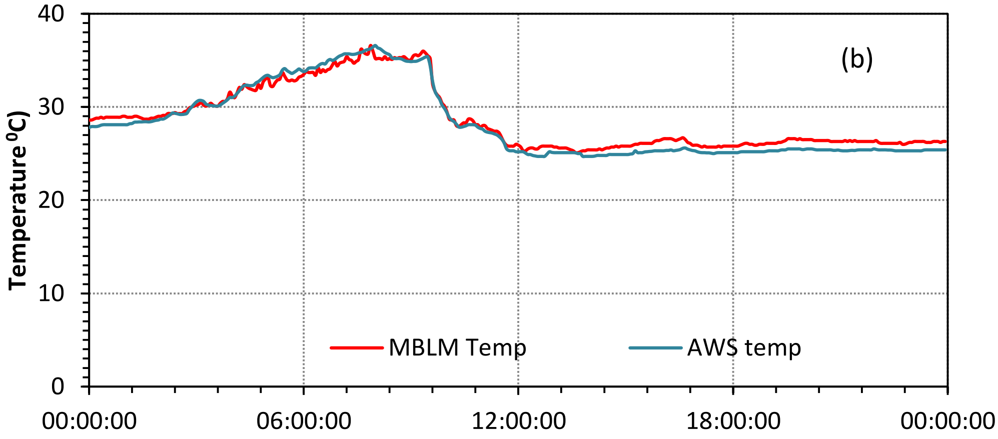


Fig.6: Evaluation of performance of the Portable–Automatic Weather Station (AWS) using Mini-Boundary Layer Mast (MBLM) observations (a) Diurnal variation of temperature observed on clear sunny day (20 April 2009). (b) Diurnal variation of Temperature observed on passage of thunderstorm precipitating clouds on 22 April 2009.

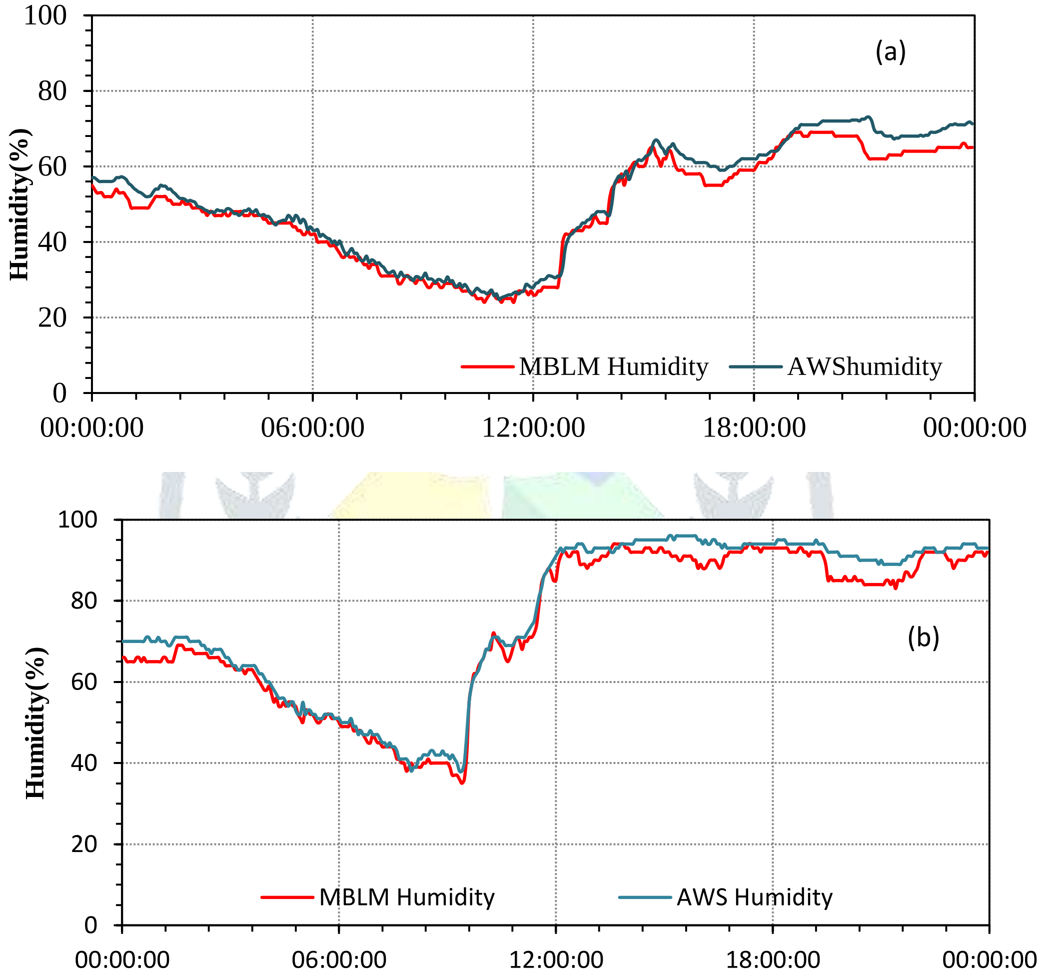


Fig. 7: Mini-Boundary Layer Mast (MBLM) and Portable –AWS observations.
(a) Diurnal variation of relative humidity observed on clear sunny day on 20 April 2009.
(b) Diurnal variation of relative humidity observed on passage of precipitating clouds on 22 April 2009.

V STUDY OF METEOROLOGICAL PARAMETERS DISTRIBUTION OVER KADAPA AND NELLORE

From figure 8, one can notice distinct tropical wet and dry climatic season in Nellore and Kadapa. From the Climatic station observations over Nellore, it is noticed that daily maximum temperatures 40°C and above during April and May, the hottest months in the year2010 and in January and February the coolest months temperature is around 20 °C (degree Celsius). Minimum and Maximum temperature are rapidly decrease in the month of May due to ***Lila*** Cyclone and also the large variations in temperature and relative humidity are observed during June to December. These variations are due to South-West monsoon (June to September), North-East monsoon (October to December) and ***JAL*** Cyclone (4 to 8thNovember). The Maximum temperature varies 26 to 45°C and minimum temperature varies15 to 24°C in the year of 2010.

Figure 8 shows the surface meteorological parameters (maximum/minimum temperature, relative humidity at 08:30 and 05:30 hrs Local Time, Wind speed and wind direction) observed from January 2010 – December 2010. From this figure the most important feature of seasonal alternation of atmospheric flow patterns associated with the summer/southwest (SW: June to September) monsoon and winter/northeast (NE: November – December) monsoon can be clearly noticeable. During the NE monsoon, the general flow of surface air over the region is from northeasterly, mainly of continental origin with low humidity and also substantial precipitation falls over this region. In the SW monsoon the surface winds take the opposite direction from sea to land, bringing with them vast amounts of moisture, cloudiness and precipitation. Between these two principal seasons are the transitional seasons of the hot weather or pre-monsoon months from March to May, and retreating monsoon or post-monsoon month, October.

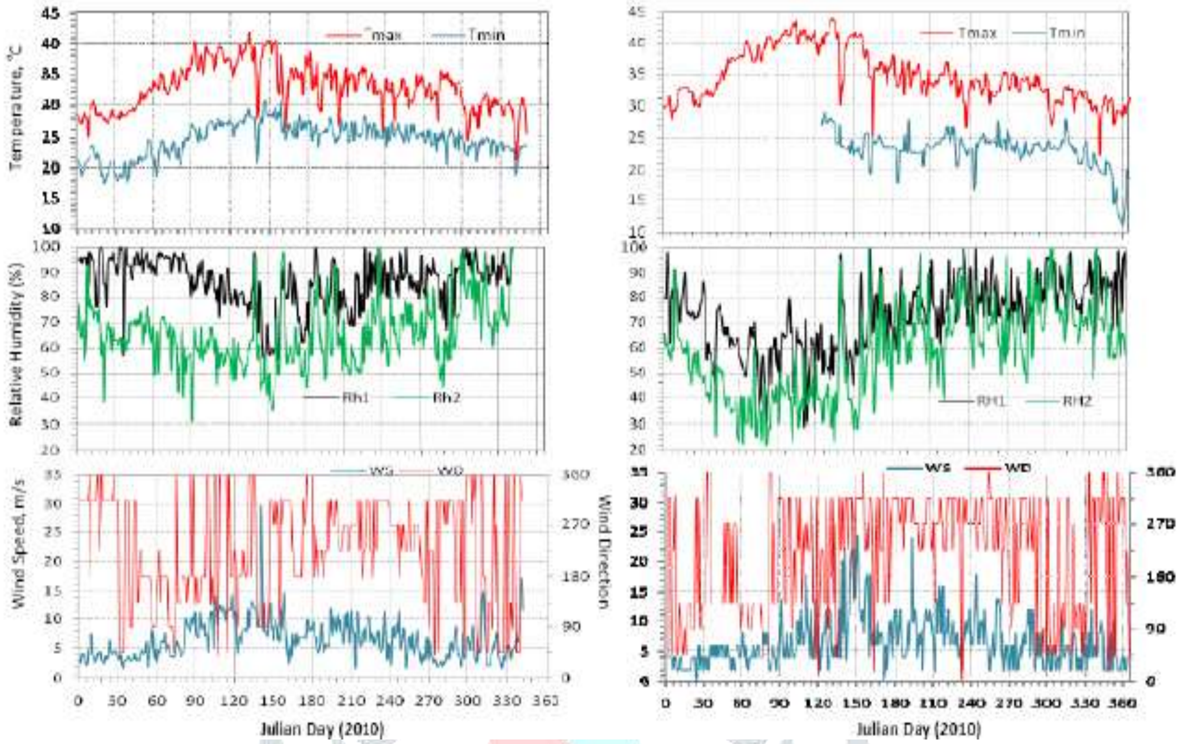


Fig. 8: Surface meteorological data collected from climatic Stations over Nellore (left three panels) and Kadapa (right three panels) from 01 January to 31 December 2010. Daily variation of maximum and minimum temperature. Middle panels show relative humidity in the morning transition.[08:30hrs (Rh1)] and evening transition[17:30 hrs (Rh2)]. panels represents average wind speed and wind direction.

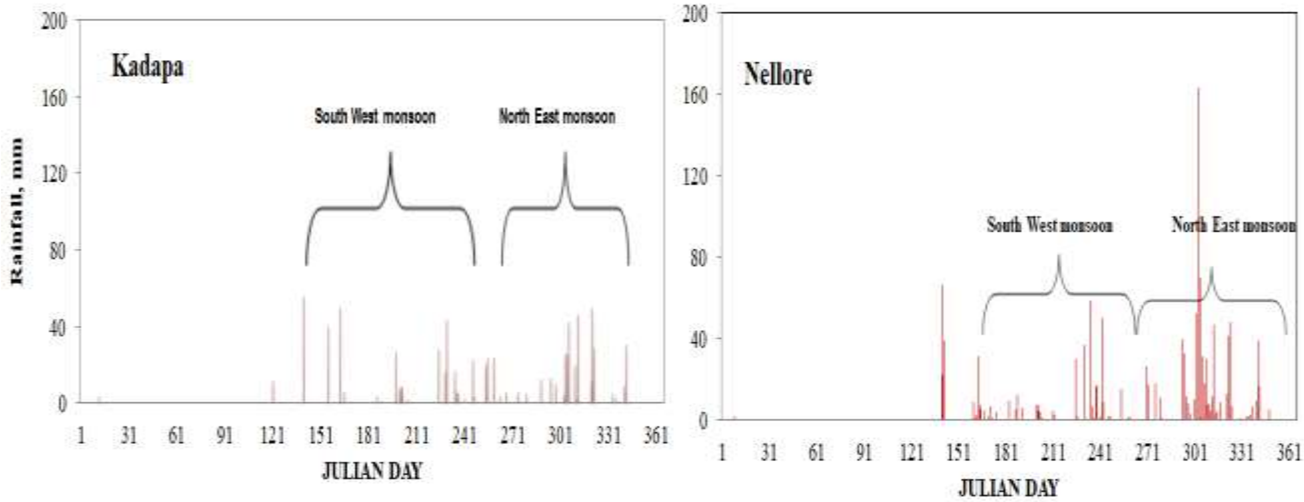


Fig. 9: 24-hours accumulated Surface Rainfall observations during different seasons of the year 2010. Daily rainfall distribution over (a) Nellore and (b) Kadapa from 01 Jan. 2010 to 31 December 2010.

Figure 9 shows daily rainfall accumulation over Kadapa and Nellore from 01 January 2010 to 31 December 2010. It is evident that numbers of rain days are more over Nellore than Kadapa. In addition, rainfall accumulation also higher at Nellore than at Kadapa. During north-east (NE) monsoon, in couple of cyclones formed over Bay of Bengal may landfall over east coast region. Due to this reason, it can be observed that more rainfall accumulation in NE monsoon than South-West Monsoon. From figure 9, one can notice annual rainfall over Nellore is higher than Kadapa region and most of the rainfall is received from June to September. Rainfall activity continues falling up to the end of December over Nellore but over Kadapa region it ends mid November. Over Nellore in the months of October, November and December receive more than half of the annual rainfall. The annual rain fall of the Nellore is 1378 mm but most of the rainfall is received in the North east monsoon which is around 800 mm.

Figure 10 shows monthly accumulated rainfall observed over Kadapa and Nellore from 01 January 2010 to 31 December 2010. In both districts, the rainfall accumulation is maximum during NE monsoon when compared with SW monsoon. This could be due to tropical cyclone effect and also strength of inter-tropical convergence zone (ITCZ). Using figures 9 and 10, daily rainfall, monthly and season accumulation of rainfall information is disseminated to the villagers through SMS and e-mails. These data is very much useful for the farmers for Kharif and Rabi season cultivations.

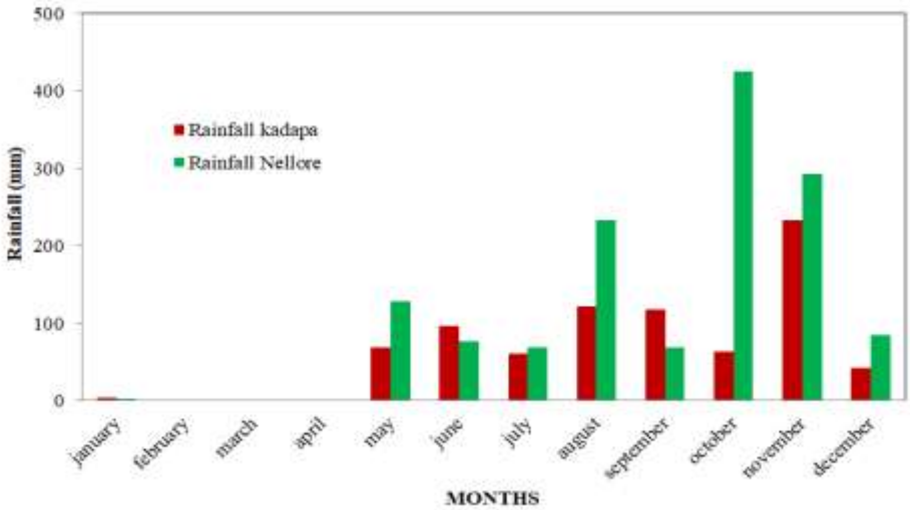


Fig.10: Monthly accumulated rainfall over Kadapa and Nellore

VI. SUMMARY AND CONCLUSIONS

Two Automatic Weather Stations (AWS) are installed at Mypadu village, Nellore district and at Inagalur, Kadapa district to monitor two different climatic regions. Initially these two AWS are temporarily installed at Semi-arid zonal Atmospheric Research Centre (SARC), Yogi Vamana University, Kadapa for calibration (CAL) and validation(VAL). From the CAL/VAL studies it is found that both AWS are useful for dissemination of meteorological parameters data to farmers. From the AWS, it is observed that daily and monthly rainfall accumulation data is also very much useful to villagers for cultivation.

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