WINDS

Weather Information Network Data System

MANUAL FOR IMPLEMENTATION

JANUARY 2023

NCFC

कृषि एवं किसान
कल्याण मंत्रालय
MINISTRY OF
AGRICULTURE AND
FARMERS WELFARE

सत्यमेव जयते

Pradhan Mantri Fasal Bima Yojana

Restructured Weather Based Crop Insurance Scheme (RWBCIS)

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Preface

Since the introduction of weather-based crop insurance in India there have been many challenges encountered in respect of installation and siting condition of the Automatic Weather Stations (AWS). Guidelines issued by World Meteorological Organization (WMO) and IMD (India Meteorological Department) but these guidelines are made in view of synoptic measurements that are used in research and forecasting purpose. However, in Pradhan Mantri Fasal Bima Yojana (PMFBY) & Restructured Weather Based Crop Insurance Scheme (RWBCIS) the very purpose, aim and objectives of meteorological observations/measurements are entirely different.

On the background of climate change and its direct and indirect impact on the agriculture sector like increased agriculture risk due to extreme weather events, frequent drought and flooding conditions increased dry spells of rainfall and increased rainfall intensity. Weather-based crop insurance is essential to reduce agriculture risk. On the appearance of weather-based crop insurance schemes, there is an urgent need to increase the density of the AWS/Automatic Rain Gauge (ARG) network as well as formulate the practical AWS siting norms which fulfil the aims and objectives and ensure the data quality for insurance schemes. Earlier in 2015 Government of India (GoI) attempted to formulate these norms / guidelines. This report aims to revise or reformulate the norms considering the on-field practical aspects and issues which have been missed in earlier norms/guidelines.

Department of Agriculture & Farmer Welfare (DA & FW) is in process of nationwide rollout of Crop Yield Estimation system based on the Technology under PMFBY. Availability of weather data at IU level is very important for preparation of term sheet in RWBCIS and also an important input in yield estimation using technology. Accordingly, DA & FW is considering to create a Weather Information Network Data System (WINDS) under PMFBY/RWBCIS. The Sub-committee has been formed to draft practical norms & guidelines to make standardised weather data infrastructure across the country.

Members of the Committee are:

S. No	Name of Expert	Designation
1	Director MNCFC	Chair
2	Representative of NRSC	Member
3	Representative of SAC	Member
4	Dr. AVM Subba Rao, Principal Scientist, CRIDA-ICAR	Member

S. No	Name of Expert	Designation
5	Dr. C N Prabhu, Joint Director, Bihar Mausam Seva Kendra, Ex-KSNDMC	Member
6	Dr. Sunil Kumar, Asst. Comm. DA & FW	Member
7	Shri. Uday Deshmukh, Project Manager (NHM) Maharashtra, Pune	Member
8	Dr. Sheshakumar Goroshi, Scientist-E, IMD	Member
9	Commissioner (Agriculture), Andhra Pradesh	Member
10	Commissioner (Agriculture), Rajasthan	Member
11	Dr. Sunil Dubey, Deputy Director, MNCFC	Member Secretary

The committee, throughout the discussion and interaction, focused on the specific purpose of use of AWS & ARGs for PMFBY & RWBCIS. The practical difficulties experienced in obtaining suitable and secure land /location for the installation of AWS/ARG. in the process, on practical aspect WMO and IMD guidelines have been relaxed without compromising on the need for data accuracy and quality to the extent required primarily for crop insurance purpose.

During this formulation of the norms, the views and suggestions form the stakeholders and experts have been considered.

We wish to acknowledge our sincere thanks to the Credit division of DA&FW, Ministry of Agriculture & Farmers Welfare, Government of India for forming the committee to prepare the norms for nationwide implementation, standardization, and improvement of weather data infrastructure under PMFBY/RWBCIS.

Chair of the committee

Abbreviations:

ARG	: Automatic Rain Gauge
AWS	: Automatic Weather Station
CRIDA	: Central Research Institute for Dryland Agriculture
ICAR	: Indian Council of Agriculture Research
IMD	:India meteorological Department
KSNDMC	: Karnataka State Natural Disaster Monitoring Center
MNCFC	: Mahalanobis National Crop Forecast Center
MOSDAC	: Meteorological and Oceanographic Satellite Data Archival Centre
NHM	: National Horticulture Mission
NRSC	: National Remote Sensing Center
QCI	: Quality Council of India
RH	: Relative Humidity
SAC	: Space Application Center
SOP	: Standard Operating Procedure
TBRG	: Tipping Bucket Rain Gauge
VEDAS	: Visualization of Earth Observation Data and Archival System
WMO	: World Meteorological Organization

CHAPTER- 1

INTRODUCTION

1.1 Agricultural Situation in India

India is a land of many climates and variety of coils affording scope for diversity of agriculture. Climate (main components of which are water, air and sunshine) is the single most important factor in crop production and determines the appropriate timing for important agriculture operations like:

1. Sowing
2. Transplanting
3. Irrigation
4. Fertilizer application and use of pesticides.

That's why agriculture in India is often called "gamble with monsoon".

1.1.1 Risk of Agriculture

Globally, agriculture is exposed to multiple hazards leading to frequent crop losses. A large proportion of published literature on agricultural risks highlighted crop production risks alone because such risks lead to multiplicative effects on farmers and different sectors of economy. Exogenous factors like climate, weather, biotic agents cause agriculture production risks leading to low and uncertain crop yields. Due to climate change or climate variability, occurrence of abnormal weather events are ever increasing, causing frequent crop loses in one part or other part of the nation.

Better management of agricultural risks is one of the important strategies being implemented to address the current challenges of food security, farm income security, and climate resiliency in Indian agriculture.

The major risk to which crops are exposed during growth are:

1. Adverse weather aberrations like drought, dry-spell, flood, untimely/ inadequate/ excess rainfall, thunderstorm, hailstorm, cyclone, cold wave, frost ets.
2. Pests/diseases

It has been estimated that, on an average, 20% of the annual production is lost due to pests, plant diseases and weeds. Crops on nearly 11.6 million hectares, on average are damaged every year by natural calamities and adverse seasonal conditions.

1.1.2 Rainfall and Irrigation

1. Out of the total gross cultivated area of nearly 196 million hectares (mha), only 44% has potential irrigation facility and the remaining 56% is dependent on rainfall.

2. Barely 20% of the rainfall is utilised in the country because of the short duration in which the monsoon are active.
3. Rest of the rains goes away as run-off. Majority of the Indian farmers suffer crop losses when rains fail or are inadequate.

By considering the above uncertainty factors, Government of India supported crop insurance. The first attempt to introduce crop insurance in India was made in 1972. After realizing that individual plot level insurance is impossible to implement, a more concerted effort was made in 1979 by way of introducing Pilot Crop Insurance Scheme (PCIS), using yield index. Based on the success of PCIS, a country-wide Comprehensive Crop Insurance Scheme (CCIS) was introduced in 1985. After including more beneficial features, National Agricultural Insurance Scheme was introduced in 1999. With several pilots at further revamping after 1999, finally a more comprehensive and farmer friendly Pradhan Mantri Fasal Bima Yojana (PMFBY) is introduced in 2016.

1.2 Weather Index Insurance

Weather data forms very essential component of weather index insurance. It forms part both in setting the premium rates and deciding the pay-outs for the current period. Weather index insurance found a place in agriculture risk management tool primarily because either the indemnity-based insurance or the yield-based insurance couldn't reach all crops or areas.

Weather index therefore proxies the crop losses arising out of adverse weather events and aims to mitigate the hardship of the insured farmers against the likelihood of financial loss on account of anticipated crop loss resulting from adverse weather conditions relating to rainfall, temperature, wind, humidity etc. Pay-out structures or the term-sheets are developed covering the weather parameters & their deviations at different phenological phases of the crop.

1.3 Why Weather Index Insurance

Weather index insurance caught the imagination of the policy makers at the beginning of 21st century, and international financial institutions like the World Bank encouraging the pilots in low income countries where crop insurance could not take off for various regions, including lack of historical yield or loss data. The basic purpose of 'weather index' insurance is to estimate the percentage deviation in crop output due to adverse deviations in weather conditions. There are crop modelling and statistical techniques to precisely workout the relationships between crop output and weather parameters. This gives the linkage between the financial losses suffered by farmers due to weather variations and also estimates the pay-outs that will be payable to them.

1.4 Early Attempts on Weather Index Insurance

It's worth mentioning that the pioneering work on weather index insurance commenced over 100 years ago (1912) by J S Chakravarthi, as a mechanism to compensate crop losses. It was between 1912 and 1920, Chakravarthi of Mysore State (India) published technical papers on the subject of 'Rainfall Insurance' and a book entitled **'Agricultural Insurance: A Practical Scheme Suited to Indian Conditions'**, in 1920, describing how rainfall index could be used to guarantee pay-outs to farmers due to adverse deviations. He used rainfall data from 1870 to 1914 from India Meteorological Department (IMD) to demonstrate the utility of the index. Surprisingly, this piece of pioneering work, which is probably one of the earliest monographs on the subject, does not appear to have been taken into account in the analytical literature on agricultural insurance. It was some 85 years later that the policy makers of the modern world started advocating the very same index for low income countries.

1.5 Key Advantages of Weather Index Insurance

One key advantage of the weather index crop insurance is that the pay-outs could be made faster, besides the fact that the insurance contract is more transparent and the transaction costs are lower. Because index insurance uses objective, publicly available data it is less susceptible to moral hazard. Most importantly there are many low-income countries where no historical data whatsoever is available, except weather data, affording an opportunity to try out some sort of index insurance.

Keeping in mind the challenges with yield index insurance and advantages with weather index insurance, India started piloting **'rainfall (weather) index'** based insurance since 2003. The government from 2007 started providing subsidies in premium, and is being tested as a substitute for yield index insurance.

1.6 Automatic Weather Stations (AWSs)

One of the essential requirements for success of weather index insurance is very good density of weather stations (in order to minimize the basis risk) and transparent and near real-time availability of the weather data, to facilitate quick settlement of claims. While the initial product pilots were based on available weather station network of India Meteorological Department (IMD), but the sparse network and delay in receiving the weather data compelled the insurers to look for alternative sources of weather data beyond IMD.

That's how the private automatic weather station network started with several data providers setting up weather stations.

Individual states too, started their own efforts in setting up AWSs – some on their own and some on Public-Private Partnership (PPP or 3P) mode, with primary purpose of providing agro-advisories to farmers while facilitating research and better understanding of crop-weather relationship and determining conducive weather for pest & disease outbreak. Karnataka is among the early states to start a huge network of Automatic Rain Gauges (ARGs), followed by the undivided Andhra Pradesh, Tamil Nadu, Maharashtra, etc. Now more states like Bihar etc. started setting up ARGs.

1.7 AWSs Standards

Data sensors are the heart of AWS and their calibration and regular maintenance forms the core of generating accurate and reliable weather data. Equally important is to ensure that proper standards are followed in selecting the site for installing the AWS, free from any hindrance. With a huge financial transaction tied to the AWS by way of weather index insurance, it's more important to ensure that the instrument and the data recording and retrieval is totally tamper-proof.

1.8 Use of Weather Data in PMFBY

With introduction of Pradhan Mantri Fasal Bima Yojana (PMFBY) in 2016, weather data found several more uses.

High density and standard quality weather datasets constitute crucial inputs in multiple applications such as (a) crop insurance, (b) disaster management, (c) crop/livestock/fishery/poultry advisory, (b) crop planning/irrigation scheduling, (e) crop yield modelling, (f) infrastructure planning etc.

For example, role of weather variables is prominent in every segment of agriculture insurance value chain. Historical weather data is needed for insurance rate making, current year weather data is required for assessing mid-season adversaries, yield estimation etc. In disaster management these datasets are relevant to multiple sub-themes namely floods, cyclones, landslides etc.

Summary of weather datasets that are quite useful for multiple themes and applications are presented in Table

Sr No	Risks	Weather variables
1.	Drought/Prolonged dry spell	• Rainfall, • Rainy days • Dry days
2.	Flood	• Cumulative rainfall,

		• Rainfall intensity
3.	Cyclone	• Cumulative rainfall, • Rainfall intensity • Wind speed
4.	Hailstorm	• Rainfall
5.	Unseasonal rain	• Rainfall Amount, • Rainfall Intensity & Duration
6.	Frost	• Minimum Temperature • Sunshine hours • Wind
7.	Heat waves	• Maximum temperature
8.	Pest/Disease	• Humidity, • Temperature

1.8.1 Prevented / failed sowing / planting

The proxy indicators used to determine the benefit include rainfall data and the other weather indices (21.3.3 of PMFBY OGs). The Notification issued by the State shall include the details of the AWSs/ARGs, to be considered for the purpose of declaring the areas eligible for prevented / failed sowing / planting benefit.

1.8.2 On-Account Payment of Claims due to Mid-Season Adversity

The proxy indicators used to determine the benefit include rainfall data (adverse deviations from long period average) and the temperature deviations which may have caused increased evapotranspiration losses (21.4.3 of PMFBY OGs). The Notification issued by the State shall include the details of the AWSs/ARGs.

1.8.3 Localized Calamity

The proxy indicators used to determine the benefit include rainfall data (to measure excess rainfall that may have led to inundation / flooding (21.5.3.7 of PMFBY OGs). The Notification issued by the State shall include the details of the AWSs/ARGs.

1.8.4 Post-Harvest Losses

The proxy indicators used to determine the benefit include rainfall data (to measure the rainfall that may have led to losses of the crop harvested and lying in the field (21.6.2.4 of PMFBY OGs). The Notification issued by the State shall include the details of the AWSs/ARGs.

1.9 Dispute resolution regarding Yield Data/Crop loss

In case of significant differences in yield values as estimated by State government and the insurer, the dispute can be raised to the State Technical Supporting Unit (TSU) and still unresolved with go to National TSU. Among the various parameters considered for dispute resolution, are the weather parameters that include rainfall, rainy days and temperature (19.7.3 of PMFBY OGs)

1.10 Use of Technology in Crop Yield Estimation

PMFBY provides for use of technologies (in place of CCEs) in estimating the yields. States like Madhya Pradesh & Maharashtra have started using these technologies for 2022-23. Among the various parameters which go into the yield estimation model, are weather data like rainfall and temperature data.

As can be seen from the above, the weather data is needed not only for weather index insurance, but also extensively in PMFBY to decide the invocation of several additional benefits. It is therefore very important that the states shall maintain a good network of AWSs / ARGs. The proper maintenance of these stations and sensor standards and data quality is very crucial in getting the best out of the AWSs/ARGs network.

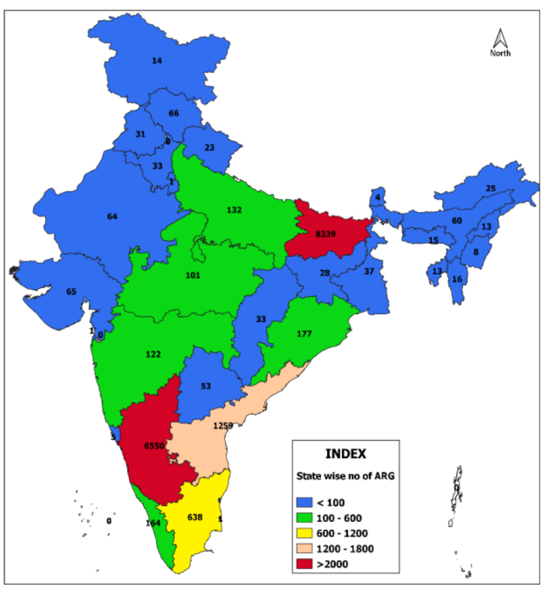

Figure 1:Present status of ARG network in India.

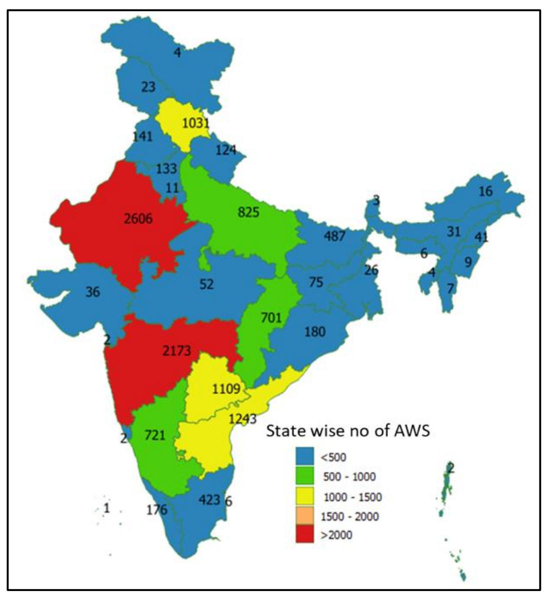

Figure 2: Present status of AWS network in India

Source of data:

1.11 Role and need of weather and climate observations and forecasting on increasing agriculture productivity and risk management

Climate change is generally attributed to increase in temperature and green-house gases across the globe. There is no doubt that it is going to affect our entire life in coming days, neither it has already started impacting our lives. We have seen that extreme events like floods, severe droughts have increased. We in India also observing that there is 4 bad monsoon years in last five years. It is such important subject that, 2007 Nobel prize was given for work in climate change.

Agriculture is deeply interconnected with weather and climate they are not only the main drivers of agricultural production, but also the dominant factors in the overall variability of food production (Selvaraju et.al., 2011), and a continuing source of disruption to ecosystem services (Howden et al., 2007).

Climate and weather information and forecasts in their current form have the potential to provide improved agriculture risk management and profitability in India. However, these forecasts and information systems may, in some instances, be ill-suited for direct use by farmers in their decision-making. To overcome this problem, it is very important to identify key agriculture decisions which would be sensitive to the information that forecast provide and which are also comparable with farmers goal and objectives. Therefore, climate and weather forecast information has to be customized in a form that is suited to influencing those key decisions. Indeed, climate and weather forecasts may have absolutely no value unless they can change these key management decisions (Stone et al., 2006).

In farmers' real world, there is need of assimilation of many aspects of complex climate, weather and agronomic information in decision making process. In this respect, interdisciplinary systems approach such as Government Institutions, Universities, NGOs, Private Sectors are especially useful in connecting the knowledge from particular disciplines in a manner most suited to farmers.

It appears from evidence in some countries that participatory interaction involving farmers, climate, and agricultural scientists promises particularly large benefits, particularly in regions subject to high levels of climate variability. Successful farm management decision-making undertaken through appropriate targeting of forecast information is already providing substantial benefit in some countries and regions, especially in Australia, India, parts of the United States of America, southern Africa, Argentina, and Brazil.

Finally, provision of information on climate change trends and scenarios of direct relevance to farmers in terms of the complexity of their medium to long-term strategic management decisions must be addressed urgently, especially in developing countries where climate change may shift more farming regions into particularly vulnerable farming zones.

On this background to fulfil the knowledge gap between the farmers and weather information/Forecasting Government of India initiate the establishment of Automatic Rain Gauge network at Gram Panchayat level and establishment of Automatic Weather

Station network at Block level across India. The very purpose of this network establishment is to use this observation for public goods such as, for implementation of welfare and development schemes, research and development, to develop weather and agro-met advisories, disaster management and to cater rehabilitation department's needs for weather data or any other purpose involving larger public interest.

Key identified agriculture decisions which would be sensitive to the information that forecast provide and which are also comparable with farmers goal and objectives are as follows:

1. Real Time Crop Monitoring & Pest/disease Forewarning
2. Crop Risk Management.
3. Real Time Online Monitoring of Seed Production Programs.
4. Real Time Crop/livestock/fishery/poultry Advisory.
5. Logistics & Supply Chain of Agriculture Products.
6. Crop Yield Estimation before Harvesting.
7. Climate Change Studies.
8. Real Time Village Level Drought Monitoring.
9. Agriculture Policy/Project Planning.

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CHAPTER-2

Establishment of National Level ARG Network at Gram Panchayat level

2.1 Technical Specification of Automatic Rain Gauge

SI No	Description	Required Specification
1	**Rain Gauge**	
a	Instrument	Tipping Bucket rain gauge
b	Orifice Size/ collector diameter	Specified diameter of the collector rim should be at least 159.5 mm
c	Collector Area	Specified Collector Area should be at least 200 cm^2
d	Reed Switch	Magnetic switch
e	Operating range	Unlimited; electrical impulse output
f	Response time	Capable of operating at rates up to 1 pulse per second.
g	Resolution	(0.25 or 0.5 mm) per tip
h	Output	Reed switch count
i	Sustainability	Up to 300 mm/hour
j	Accuracy: Maximum permissible percentage error in the measurement of rainfall	±2% or better, for rain rate up to 25 mm/hr
		±3% or better, for rain rate between 25mm/hr to 50 mm/hr
		±4% or better, for rain rate between 50mm/hr to 100 mm/hr
k	Range	Unlimited
l	Material of outer body /Housing (Base and collector)	Non-Corrosive material
m	Bucket Material	Injection molded non-hydroscopic ABS (Acrylonitrile Butadiene Styrene), UV-stabilized or brass with chrome plated or stainless steel

SI No	Description	Required Specification
n	Levelling	Suitable Levelling adjustment screws and circular spirit level must be provided on the base of TBRG for levelling the Tipping Bucket Mechanism.
o	Debris protection filter	Suitable (Wire mesh) debris protection filter should be provided inside the collector.

2.2. Siting and Exposure Condition Norms for Automatic Rain Gauge

1. The ARG will be installed at minimum height of 30 cm from ground. The maximum height of ARG can be rooftop of the one-story building (about 10 feet height from the ground).
2. 5m Area surrounding the ARG should generally be flat and open. Possible obstacles must be situated at a distance greater than the height of the obstacle.

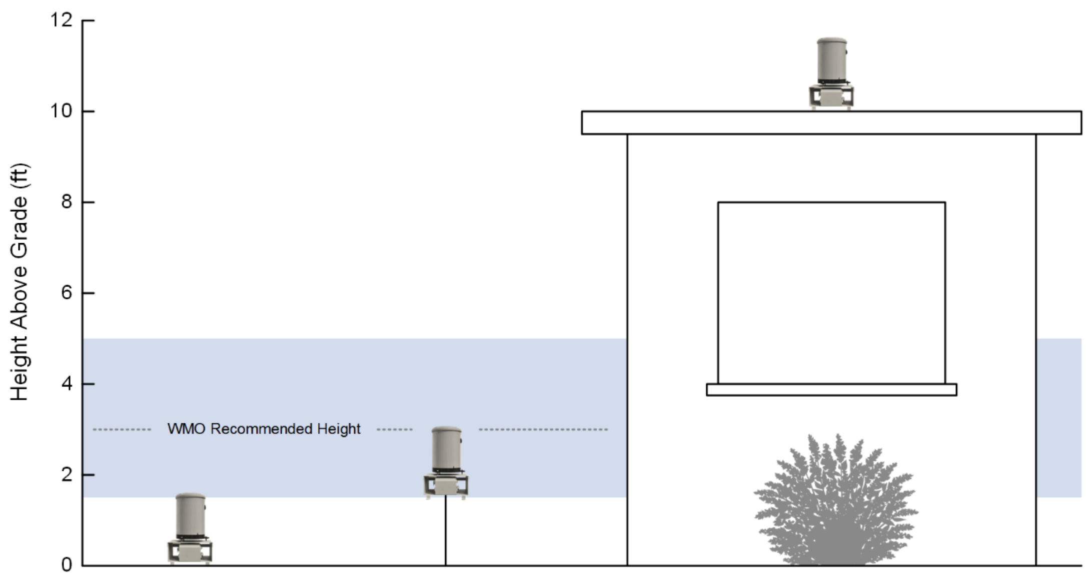

Figure 2: Most Common Rain Gauge Siting Criteria for height Above Grade

**(Source: Kevin L. Enfinger et al., ADS Environmental Services)*

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CHAPTER-3

Protocols for data transmission and data repository for ARG

3.1 Data Acquisition and Transmission

1. Microcontroller based technology shall be used for data acquisition or measurement. The measurement will be continuous process.

2. Recording Timing: 08:30:01 am of previous day to 8:30:00 am of today. For e.g. rainfall of Day 1 would be aggregate rainfall recorded from 08:30:01 am of the Day 0 to 8:30:00 am of Day 1.

3.2 Data Aggregation

1. Hourly Summary Rainfall- Cumulative (Total) rainfall recorded in one hour (sum of all the records in one hour)

3.3 Daily Summary

1. Rainfall : Cumulative (Total) rainfall recorded in one day.

3.4 Data Transmission or Reporting

1. Mobile telemetry (4G or better) shall be used for the for the data transmission. Data logger should be compatible with 4G network. It should work with sim cards of all the telecom service providers in India without exception.
2. The Data logger shall transmit the data directly to the Central Server which is owned and operated by Government of India/MNCFC (Mahalanobis National Crop Forecast Center). Simultaneously, as a fallback, the data shall be transmitted to server maintained by the service provider.
3. Data shall be transmitted on hourly basis i.e.; Hourly summary of the data shall be transmitted to the central server.
4. For data completeness, 90% of the total records must be required.

3.5 Central Receiving Station

For data reception, processing, Storing and dissemination, central receiving station shall be established. Peripheral equipment such as a stabilized power supply providing power to the various parts of the station, a real-time clock, and built-in test equipment for automatic monitoring of the status of vital parts of the station. Specific applications, display devices and printers, or recorders are added to the station.

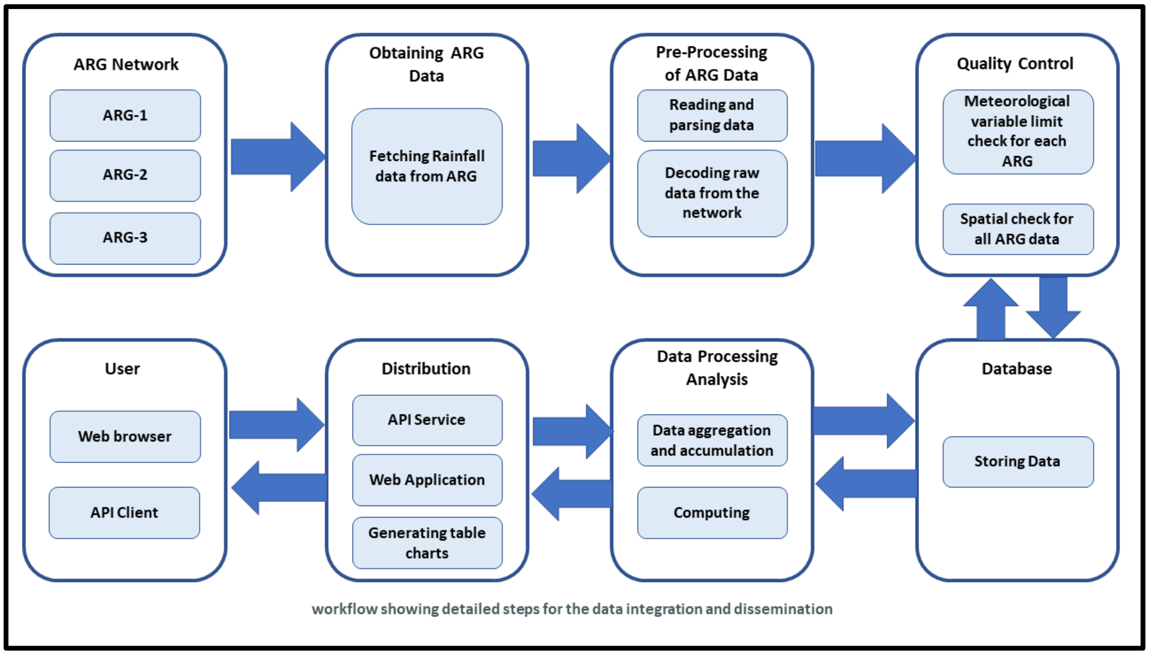

Figure 3: Workflow of ARG station

3.6 Data Accessibility

ARG data stored at central server can be accessible to:

1. Daily Summary: General public, Citizens
2. Hourly Summary: Research Institutions, Banks, Insurance sector, starts ups etc.
3. All Data (Daily summary and Hourly Summary) will be accessible to the Central Government as well as the State Government free of cost.

3.7 Data Acquisition System

This is the heart & brain of the ARG station. Here the data is collected from the various sensors & processed for transmission. The quality & life of the AWS station is wholly dependent upon the data logger. While selecting a data logger the following points should be taken into consideration:

1. It should have an adequate number of analogue & digital channels.
2. It must be configurable at the user end.
3. It should have sufficient communication ports.
4. It must be remotely programmable.
5. It must have open architecture to connect any commercially available sensor.
6. It must have its own operating system and compiler.

7. The software of the data logger should be able to check the quality of the data collected by the sensors.

3.8 Battery

The battery must be maintenance free & it must be of such a capacity that the ARG station will run uninterrupted even in completely cloudy weather for at least 30 days.

3.9 Solar Panel

The solar panel should be enough rating to charge the battery during sun.

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CHAPTER-4

Data Validation for ARG

For validation of the data Automatic Quality Control algorithm need to be implemented.

4.1 Automatic Quality Control

To maintain the data quality certain check points or tests has been applied and performed at automatic weather station. Some check points are performed partly at automatic weather station and partly at data processing centre (MNCFC Server).

4.1.1 Plausible Value Check:

The aim of the test is to verify whether the values are within acceptable range limits depending on the climatic conditions of the measurement site and the season. The check provides information as to whether the values are erroneous or suspect.

4.1.2 Range test:

The range test is based upon a combination of performance specifications for each sensor and the annual, seasonal and monthly climatic extremes. Each parameter has predetermined limits (Lookup tables). Any observation that occurs outside of the maximum or minimum allowable value is flagged as a ‘‘failure.’’

4.1.3 Step Test

The step test compares the change between successive observations. If the difference exceeds an allowed value, distinct for each parameter, the observation is flagged as a ‘‘warning.’’ If either one of the data points used in the comparison are missing, the test indicates a null result for those pairs; other tests determine which data point is missing. (The step test has proven useful for detecting erroneous readings due to loosen wires or datalogger problems.)

4.1.4 Temporal Consistency/variability Check

1. The measured rate of change of a meteorological parameter is checked against a maximum physically acceptable temporal variability or against a maximum climatological plausible variability in a specified time interval.
2. The measured rate of change between two consecutive measures is tested against a minimal required variability in a certain period.

4.1.5 Internal Consistency Test

1. Under this check all tests of the consistency of the different parameters measured at the same site, as, for example, non-zero rain with relative humidity below a threshold value.
2. Check no of data points, it should be 24 (always).
3. Data points must be of 60 minutes interval.

4.1.6 Persistence Test

The persistence test checks an entire day's data from a single station, one parameter at a time. The mean and standard deviation for that parameters are calculated. If standard deviation is below acceptable minimum, the corresponding data values are flagged as either "suspect" or "warning", depending upon the departure of the standard deviation from the minimum threshold (i.e. 3σ). The persistence test is useful for determining damaged/defective instruments or those ''stuck'' at a particular reading.

4.1.7 Spatial Consistency Check.

In this test the data is checked and compared with the surrounding nearby automatic weather station's data. First, an outlier detection is performed on both the station data being quality checked and the data of the surrounding stations using the daily timeseries of each station. If an outlier is detected for the station being quality checked, then the data fails the spatial consistency test. Otherwise, we test on an hourly basis whether the analysed station value falls inside a confidence interval formed from surrounding stations data that were not classified as outliers. Measurements that fail the test are flagged as suspect or erroneous depending upon the departure of the data from the confidence interval.

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CHAPTER-5

Maintenance and Calibration of ARG Station Installed at GP Level

It is evident that any complex system requires maintenance support. Therefore, SOP of Maintenance shall be prepared and adopted.

5.1 Maintenance

5.1.1 Preventive Maintenance:

Preventive maintenance should be done quarterly. To minimize corrective maintenance and to increase the performance of an AWS, well-organized preventive maintenance shall always be preferred.

5.1. 2 Corrective Maintenance/ Trouble Shooting:

Corrective maintenance should be on call there is no constraints. Corrective maintenance must be attended within 3 working days from the day of fault/breakdown reported.

5.1.3 Adaptive Maintenance

Adaptive maintenance is required to take into account the rapid changes in technology and the availability of spare parts after a few years.

5.2. Calibration

AWS sensors with electrical outputs, show accuracy drifts in time and, consequently, need regular inspection and calibration. In principle, the calibration interval is determined by the drift specifications given by the manufacturer and the required accuracy. As signal conditioning modules and data-acquisition and transmission equipment also form a part of the measuring chain, their stability and correct operation also must be controlled or calibrated periodically.

5.2.1 Field Inspection

The periodic comparison of AWS sensors with travelling standards at the station is an absolute requirement to monitor the performance of the sensors. Before and after field inspections, the travelling standards and reference sources must be compared with the working standards of the calibration laboratory. The maintenance service must be informed as soon as possible when accuracy deviations are detected.

5.2.2 Laboratory Calibration

Instruments at the end of their calibration interval, instruments showing an accuracy deviation beyond allowed limits during a field inspection and instruments repaired by the maintenance service, should return to a calibration laboratory prior to their re-use. Sensors should be calibrated in a conditioned environment (environmental chambers) by means of appropriate working standards. These working standards should be compared and calibrated periodically with secondary standards and be traceable to international standards. Attention should also be paid to the calibration of the different components forming the measuring and telemetry chain, in particular the signal-conditioning modules. This involves appropriate voltage, current, capacitance and resistance standards, transmission test equipment and high-accuracy digital multi-meters. Highly accurate instruments or data-acquisition systems are required for calibration. A schedule should be set up to compare periodically the secondary standards of the calibration laboratory with WMO primary standards.

5.2.3 Third Party Weather Station Accreditation and Data Verification

As explained earlier, the siting and exposure of stations have an important influence on the performance of the stations and quality of the data. Hence, it is important to verify the weather station location, sensor specifications etc., to ensure the quality of weather data as this data is important for insurance claim settlement. it is important to verify the whole network physically once in a year and data quality on regular basis through a Quality Council of India (QCI) or any accredited body by state Govt/GoI for such work, who uses many different information sources, such as reference stations, neighbouring stations, geographic and topographic data, climatological data, model calculations, satellite information, etc. Though it takes extensive and very costly efforts to construct a perfect quality control system, rational and effective manual control can reduce the number of incorrect observations in the data stream. States or the Government of India should clarify regarding the cost of such accreditation while floating the tender or work order.

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CHAPTER-6

Establishment of National Level AWS Network at Block Level

6.1 AWS Sensor Technical Specifications

AWS station to be establish at block level must have the following sensors

- Air Temperature
- Relative Humidity
- Wind Speed
- Wind Direction
- Rainfall/Precipitation (Tipping Bucket Rain gauge)

SI No	Description	Required Specification
1	**Rain Gauge**	
A	Instrument	Tipping Bucket rain gauge
B	Orifice Size/ collector diameter	Specified diameter of the collector rim should be at least 159.5 mm
C	Collector Area	Specified Collector Area should be at least 200 cm^2
D	Reed Switch	Magnetic switch
E	Operating range	Unlimited; electrical impulse output
F	Response time	Capable of operating at rates up to 1 pulse per second.
G	Resolution	(0.1 0.25 or 0.5 mm) per tip
H	Output	Reed switch count
I	Sustainability	Up to 300 mm/hour
J	Accuracy: maximum permissible percentage error In the measurement of rainfall	±2% or better, for rain rate up to 25 mm/hr
		±3% or better, for rain rate between 25mm/hr to 50 mm/hr
		±4% or better, for rain rate between 50mm/hr to 100 mm/hr
K	Range	Unlimited
L	Material of outer body /Housing (Base and collector)	It should be non-corrosive material
M	Bucket Material	Injection moulded non-hydroscopic ABS (Acrylonitrile Butadiene Styrene), UV-stabilized or brass with chrome plated or stainless steel
N	Levelling	Suitable Levelling adjustment screws and

SI No	Description	Required Specification
		circular spirit level must be provided on the base of TBRG for levelling the Tipping Bucket Mechanism.
O	Debris protection filter	Suitable (Wire mesh) debris protection filter should be provided inside the collector.
2	**Temperature**	
A	Type	PT100 1/3 class B or solid state or equivalent
B	Range	-20°C to 60°C
C	Resolution	0.1 °C
D	Accuracy (With Radiation shield)	±0.2 °C
E	Response time	< = 45 seconds
F	Out put	Digital
G	Louvered Radiation shield	UV Resistant (Minimum 6 Louvers)
3	**Humidity**	
A	Type	Capacitive / Solid state sensor with protective coating
B	Range	0 to 100 % RH
C	Resolution	1 % RH
D	Accuracy (With Radiation shield)	±5% for RH 0 to 50%, ±3% for RH >50%
E	Response time	<=45 sec
F	Out put	Digital OR Analog
G	Louvered Radiation shield	UV Resistant (Minimum 6 Louvers)
4	**Wind Speed and Direction**	
A	Type	Ultrasonic
B	Measurement Range (Wind Speed)	0-75 m/s
C	Measurement Range (Wind Direction)	$0\text{-}359^0$
D	Resolution (Wind Speed)	0.1 m/s
E	Resolution (Wind Direction)	1^0
F	Accuracy (Wind Speed)	±2% upto 50 m/s and < ±3 % above 50 m/s
G	Accuracy (Wind Direction)	$\pm 3^0$
H	Output	Digital

6.2 Siting and Exposure Condition Norms

1. Site for installation of the AWS to be provided by respective state governments. It would be responsibility of the tender floating agency to provide safe and secure sites for the installation.
2. The AWS is to be located on a level piece of ground, covered with short grass or natural earth ideally 5 m x 7 m in dimension. In cases of non-availability of space, 5 m x 5 m would be sufficient.
3. The proposed AWS site must be free from obstructions like tall buildings, trees, etc.
4. The site should be free from any encumbrance.
5. Surroundings should be assessed for potential obstructions to selected sensors.
6. Potential sensor contaminants (e.g., water and dust sources) should be identified.
7. The site should preferably be located on the same level as the roadway of the station.
8. The site must be selected in such a way that the distance between the fencing of the site and the proposed AWS mast should be at least 2 meters. This distance is recommended to minimize the effect of the fence on the sensor's readings especially when weeds and/or debris on the fence act as a horizontal obstruction.
9. Conditions to be avoided:

   a. Steep slopes, sheltered hollows, high vegetation, shaded areas, or swamps

   b. Obstructions like tall buildings, trees etc.

   c. Location of the site on the edge of a slope, hillocks, cliff or inside a valley

   d. Large industrial heat sources

   e. Locations near high-tension power lines

   f. Low places holding standing water after rains

   g. Underground obstructions like buried cables or conduits

   h. Pollution influence from surrounding farms and towns

6.3 Siting Classification

WMO Siting Classification based on (Guide to meteorological Instruments and Method of Observation, WMO No.8, 2008):

In this Guide WMO defines the representativeness of the area/region as, the representativeness of an observation is the degree to which it accurately describes the value of the variable needed for a specific purpose. Therefore, it is not a fixed quality of any observation, but results from joint appraisal of instrumentation, measurement interval and exposure against the requirements of some application. For instance, synoptic observations should typically be representative of an area up to 100 km around the station, but for small-scale or local applications the considered area may have dimensions of 10 km or less.

Applications have their own preferred timescales and space scales for averaging, station density and resolution of phenomena small for agricultural meteorology, large for global long-range forecasting. Forecasting scales are closely related to the timescales of the phenomena; thus, shorter-range weather forecasts require more frequent observations from a denser network over a limited area in order to detect any small-scale phenomena and their quick development. Using various sources (WMO, 2003a; 2001; Orlanski, 1975), horizontal meteorological scales may be classified as follows, with a factor two uncertainty

a) Microscale (less than 100 m) for agricultural meteorology, for example, evaporation.
b) Toposcale or local scale (100–3 km), for example, air pollution, tornadoes.
c) Mesoscale (3–100 km), for example, thunderstorms, sea and mountain breezes.
d) Large scale (100–3 000 km), for example, fronts, various cyclones, cloud clusters.
e) Planetary scale (larger than 3 000 km),

6.3.1 Temperature and Humidity

Minimum siting classification norms for temperature and humidity sensor should be as follows:

1. Ground covered with natural and low vegetation (<25 cm) representative of the region.
2. No irrigation or routine lawn watering system within 5m radius.
3. No significant heat source or reflective surface (buildings, roads, concrete surface) within 10m radius.
4. Open water source can be excluded, if 60 % of the region (insurance unit) is covered by the water source or large-scale inland water
5. Minimum distance from sensor to nearby other objects at least 1x the height of the object away.

6.3.2 Wind

Minimum siting classification norms for wind sensor should be as follows:

(WMO guidelines for wind are defined for 10m tower height (i.e 10m tower), However for agriculture purpose wind mast height is 3m. Therefore, following guidelines are reduced in proportion to 3m).

1. The sensors are mounted on a tower at 3m above the ground.
2. Surrounding obstacles must be at least 1.5 times their height away from wind tower.
3. Individual obstacles (i.e shade, fence, short trees etc.) lower than 1.5m above ground can be ignored.

4. Objects higher than 2.4m above ground must be at least 3 times their width away from the wind tower.

6.3.3 Rain gauge (TBRG)

Minimum siting classification norms for tipping bucket rain gauge should be as follows:

1. Generally flat and open area within 5m of the sensor. This area surrounded by generally open space with slope of less than 30^o.
2. Possible obstacles must be situated at a distance greater than the height of the obstacle.

6.4 Exposure Condition of the sensors

6.4.1 Temperature and Humidity

The standard measurement height of temperature and relative humidity sensor is 1.25 meter to 2 meters from the surface. The sensor must be place in radiation shield.

6.4.2 Wind Speed and Direction Sensor

The wind sensor required to be placed or installed on a mast, at the height of 3 meters from the surface.

6.4.3 Tipping Bucket Rain gauge

1. The rainfall sensor (TBRG) required to be installed at a minimum height of 30 cm from the surface.
2. In flood prone region it needs to be installed at 1-meter height from the surface.

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CHAPTER-7

Protocols for data transmission and data repository of AWS Station

7.1 Data Acquisition and Transmission

1. Microcontroller based technology shall be used for data acquisition or measurement.
2. Recording Timing: 08:30:01 am to 8:30:00 am (Todays data = starting from 08:30:01 am of previous day to 08:30:00 of measurement day)
3. Measurement of the weather parameters shall be conducted in the following manner:

   Temperature : Continuous (one minute)

   Humidity : Continuous (one minute)

   Wind speed : Continuous (one minute)

   Rainfall : Continuous

7.2 Data Averaging

The averaging period of the measurement shall be one hour.

7.3 Hourly Summary:

1. Tavg : Average value of the temperature measured in one hour (average of 60 records)
2. Tmax : Maximum value of the temperature recorded in one hour (out of 60 records)
3. Tmin : Minimum value of the temperature recorded in one hour (out of 60 records)
4. RH : Average value of the relative humidity recorded in one hour (Average of 60 records)
5. Wind Speed : Average value of the wind speed recorded in one hour
6. Max W Speed : Maximum value of wind speed recorded in one hour
7. Min W Speed : Minimum value of wind speed recorded in one hour
8. Avg W Dir : Average value of the wind direction in one hour
9. Rainfall : Cumulative (Total) rainfall recorded in one hour (sum of all the records in one hour)

7.4 Daily summary

1. Tmax : Maximum of maximum temperature recorded in one day (out of 24 records)

2. Tmin : Minimum of minimum temperature recorded in one day (out of 24 records)
3. RH at 08:30 am: Relative Humidity of 08:30 am/Relative Humidity (Morning)/RH-I
4. RH at 05:30 pm: Relative Humidity of 05:30 pm/Relative Humidity (Evening)/RH-II
5. Wind Speed : Average value of the wind speed recorded in one day (average of 24 records)
6. Max W Speed : Maximum value of wind speed recorded in one day (out of 24 records)
7. Min W Speed : Minimum value of wind speed recorded in one day (out of 24 records)
8. Avg W Dir : Average value of the wind direction recorded in one day (average of 24 records)
9. Rainfall : Cumulative (Total) rainfall recorded in one day (sum of 24 records).

7.5 Data Transmission or Reporting

1. Mobile telemetry (4G or better) shall be used for the for the data transmission. Data logger should be compatible with 4G network. It should work with sim cards of all the telecom service providers in India without exception.
2. The Data logger shall transmit the data directly to the Central Server which is owned and operated by Government of India/MNCFC (Mahalanobis National Crop Forecast Center). Simultaneously, as a fallback, the data shall be transmitted to server maintained by the service provider.
3. Data shall be transmitted on hourly basis i.e.; Hourly summary of the data shall be transmitted to the central server.
4. For data completeness, 90% of the total records must be required.

7.6 Central Receiving Station

For data reception, processing, Storing and dissemination, central receiving station shall be established. Peripheral equipment such as a stabilized power supply providing power to the various parts of the station, a real-time clock, and built-in test equipment for automatic monitoring of the status of vital parts of the station. Specific applications, display devices and printers, or recorders are added to the station.

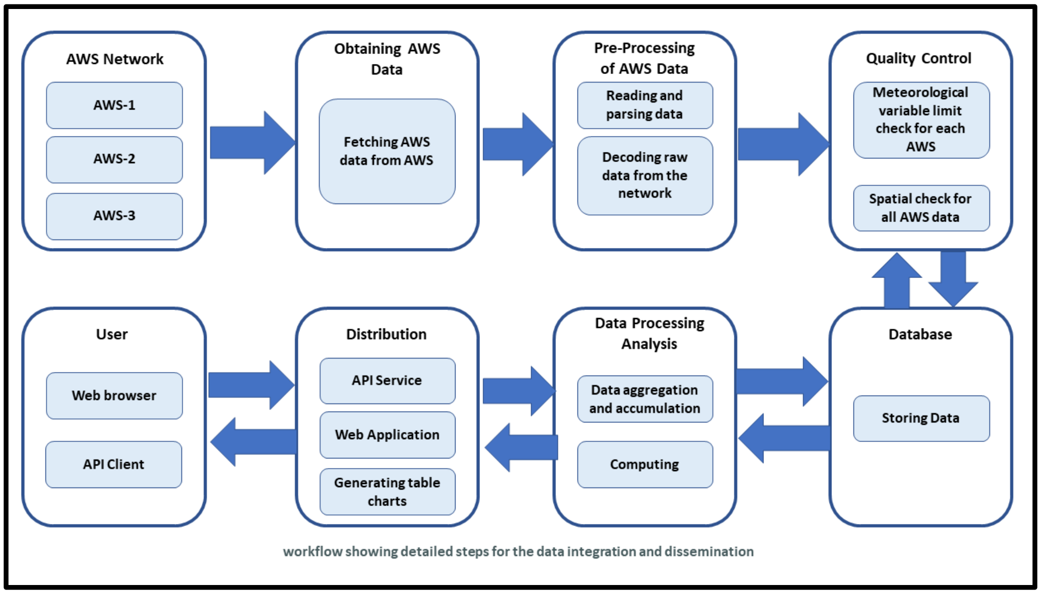

Figure 4:Workflow of AWS station

7.7 Data Acquisition System

This is the heart & brain of the AWS station. Here the data is collected from the various sensors & processed for transmission. The quality & life of the AWS station is wholly dependent upon the data logger. While selecting a data logger the following points should be taken into consideration:

1. It should have adequate number of analogue & digital channels.
2. It must be configurable at the user end.
3. It should have sufficient communication ports.
4. It must be remotely programmable.
5. It must have open architecture to connect any commercially available sensor.
6. It must have its own operating system and compiler.
7. The software of the data logger should be able to check the quality of the data collected by the sensors.

7.8 Battery

The battery must be maintenance free & it must be of such a capacity that the AWS station will run uninterrupted even in completely cloudy weather for at least 30 days.

7.9 Solar Panel

The solar panel should be enough rating to charge the battery during sun.

7.10 Data Accessibility

AWS data stored at central server can be accessible to:

1. Daily Summary: General public, Citizens
2. Hourly Summary: Research Institutions, Banks, Insurance sector, starts ups etc.
3. All Data (Daily summary and Hourly Summary) will be accessible to the Central Government as well as the State Government free of cost.

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CHAPTER - 8

Data Validation of AWS installed at Block level

For validation of the data Automatic Quality Control algorithm need to be implemented.

8.1 Automatic Quality Control

To maintain the data quality certain check points or tests has been applied and performed at automatic weather station. Some check points are performed partly at automatic weather station and partly at data processing centre (MNCFC Server).

8.1.1 Plausible Value Check

The aim of the test is to verify whether the values are within acceptable range limits depending on the climatic conditions of the measurement site and the season. The check provides information as to whether the values are erroneous or suspect.

8.1.2 Range test

The range test is based upon a combination of performance specifications for each sensor and the annual, seasonal and monthly climatic extremes. Each parameter has predetermined limits (Lookup tables). Any observation that occurs outside of the maximum or minimum allowable value is flagged as a ‘‘failure.’’

8.1.3 Step Test

The step test compares the change between successive observations. If the difference exceeds an allowed value, distinct for each parameter, the observation is flagged as a ‘‘warning.’’ If either one of the data points used in the comparison are missing, the test indicates a null result for those pairs; other tests determine which data point is missing. (The step test has proven useful for detecting erroneous readings due to loose wires or datalogger problems.)

8.1.4 Temporal Consistency/variability Check

1. The measured rate of change of a meteorological parameter is checked against a maximum physically acceptable temporal variability or against a maximum climatological plausible variability in a specified time interval.
2. The measured rate of change between two consecutive measures is tested against a minimal required variability in a certain period.

8.1.5 Internal Consistency Test

1. Under this check all tests of the consistency of the different parameters measured at the same site, as, for example, non-zero rain with relative humidity below a threshold value.
2. Check no of data points, it should be 24 (always).

3. Data points must be of 60 minutes interval.

8.1.6 Persistence Test

The persistence test checks an entire day's data from a single station, one parameter at a time. The mean and standard deviation for that parameters are calculated. If standard deviation is below acceptable minimum, the corresponding data values are flagged as either "suspect" or "warning", depending upon the departure of the standard deviation from the minimum threshold (i.e. 3σ). The persistence test is useful for determining damaged/defective instruments or those ''stuck'' at a particular reading.

8.1.7 Spatial Consistency Check.

In this test the data is checked and compared with the surrounding nearby automatic weather station's data. First, an outlier detection is performed on both the station data being quality checked and the data of the surrounding stations using the daily time series of each station. If an outlier is detected for the station being quality checked, then the data fails the spatial consistency test. Otherwise, we test on an hourly basis whether the analysed station value falls inside a confidence interval formed from surrounding stations data that were not classified as outliers. Measurements that fail the test are flagged as suspect or erroneous depending upon the departure of the data from the confidence interval.

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CHAPTER-9

Maintenance and Calibration of AWS

9.1 Maintenance

It is evident that any complex system requires maintenance support. Therefore, SOP of Maintenance shall be prepared and adopted.

9.1.1 Preventive Maintenance

Preventive maintenance should be done quarterly. To minimize corrective maintenance and to increase the performance of an AWS, well-organized preventive maintenance shall always be preferred.

9.1.2 Corrective Maintenance/ Trouble Shooting

Corrective maintenance should be on call there is no constraints. Corrective maintenance must be attended within 3 working days from the day of fault/breakdown reported.

9.1.3 Adaptive Maintenance

1. Adaptive maintenance is required to take into account the rapid changes in technology and the availability of spare parts after a few years.
2. The Central Data Server should be capable of providing access to online maintenance logs on a web portal for the maintenance of AWS.

9.2 Calibration

AWS sensors with electrical outputs, show accuracy drifts in time and, consequently, need regular inspection and calibration. In principle, the calibration interval is determined by the drift specifications given by the manufacturer and the required accuracy. As signal conditioning modules and data-acquisition and transmission equipment also form a part of the measuring chain, their stability and correct operation also must be controlled or calibrated periodically.

9.2.1 Field Inspection

The periodic comparison of AWS sensors with travelling standards at the station is an absolute requirement to monitor the performance of the sensors. Before and after field inspections, the travelling standards and reference sources must be compared with the working standards of the calibration laboratory. The maintenance service must be informed as soon as possible when accuracy deviations are detected.

9.2.2 Laboratory Calibration

Instruments at the end of their calibration interval, instruments showing an accuracy deviation beyond allowed limits during a field inspection and instruments repaired by the maintenance service, should return to a calibration laboratory prior to them re-use. Sensors should be calibrated in a conditioned environment (environmental chambers) by means of appropriate working standards. These working standards should be compared and calibrated periodically with secondary standards and be traceable to international standards. Attention should also be paid to the calibration of the different components forming the measuring and telemetry chain, in particular the signal-conditioning modules. This involves appropriate voltage, current, capacitance and resistance standards, transmission test equipment and high-accuracy digital multimeters. Highly accurate instruments or data-acquisition systems are required for calibration. A schedule should be set up to compare periodically the secondary standards of the calibration laboratory with WMO primary standards.

9.3 Third Party Weather Station Accreditation and Data Verification

As explained earlier, the siting and exposure of stations have an important influence on the performance of the stations and quality of the data. Hence, it is important to verify the weather station location, sensor specifications etc., to ensure the quality of weather data as this data is important for insurance claim settlement. it is important to verify the whole network physically once in a year and data quality on regular basis through a Quality council of India (QCI) or any accredited body by the State Govt/GoI for such work, who uses many different information sources, such as reference stations, neighboring stations, geographic and topographic data, climatological data, model calculations, satellite information, etc. Though it takes extensive and very costly efforts to construct a perfect quality control system, rational and effective manual control can reduce the number of incorrect observations in the data stream. States or the Government of India should clarify regarding the cost of such accreditation while floating the tender or work order.

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CHAPTER-10

Calibration Processes and Methods for AWSs and ARG Stations

Timely and frequent calibration of the sensor provides reliability, accuracy quality to the sensors as well as to the data. It can be done in the laboratory as well as on the field. In laboratory the sensors are calibrated under controlled environment. Whereas the field calibration has been done on the field in dynamic and uncontrolled environment. Field calibration can be done by two methods i) at actual field with travelling standards traceable to National Accredited laboratory and ii) By comparing with reference grade AWS station which has traceability with National Accredited laboratory. The sensors having tested, compared and calibrated by this method will be having traceability with reference standard AWS and Travelling standards used in this process.

10.1 Calibration Equipment

Figure 5: Reference standard AWS

Figure 6:Sensors collocated with Reference Grade AWS for field calibration and comparison on field

Figure 7:Reference Travelling Standard Kit for actual site calibration:

Figure 8:Reference Travelling Standard Whirling Psychrometer.

10.2 Calibration procedure

10.2.1 Standardized Procedure for Tipping Bucket Rain Gauge (TBRG)

Constant water flow generator of various intensities or rain gauge calibrator is used to calibrate the TBRG. We have rain gauge calibrator having ability to generate constant water flow of 50 mm/hr, 100 mm/hr, 200 mm/hr and 500 mm/hr. Pulse counter is used to count the pulses generated by TBRG sensor for the various intensity flow of known volume.

1. Following environmental condition has been noted and reported during each calibration
   a) Date and Hour (start/End)
   b) Air temperature (°C)
   c) Water Temperature (°C)
   d) Atmospheric Pressure (hPa)
   e) Ambient Relative Humidity (%)

2. The number of tests performed for each instrument, their description in terms of time units and/or number of tips has been documented.

3. Relative error of TBRG”
   The relative error is evaluated for each reference flow rate as:

$$e = \frac{I_{m-} I_r}{I_r} \times 100$$

where I_m is the intensity measured by the instrument and I_r the actual reference intensity provided to the instrument.

4. Five tests or a minimum of three tests has been performed for each set of reference intensities, so that five error figures are associated with each instrument. The average error and the average values of I_r and I_m are obtained by discarding the minimum and the maximum value of e obtained for each reference flow rate, then evaluating the arithmetic mean of the three remaining errors and reference intensity values.

10.2.2 Standardized Procedure for Air Temperature, Relative Humidity, Wind Speed and Direction

1. Simultaneous continuous collocated measurements with reference grade AWS sensors has been conducted for the calibration. The sensors calibrated by this method has been used to replace with the field sensor which has been detected drift or bias in on field calibration/testing with reference travelling standards.

2. Simultaneous long term (24 hrs) collocated measurements with reference grade AWS sensors has been conducted for the confirmation of the observed drift or bias in the field sensor during field calibration. Based on the result obtained from this testing the sensor has been handed over to the R & D embedded system unit for further decision i.e repair or discard the sensor.

3. Bias and precision were calculated using the equation below:

$$Bias = \frac{1}{n}\sum_{1}^{n}(S-R)$$

$$Relative\ mean\ bias = \frac{\sum_{1}^{n}(S-R)}{\sum_{1}^{n}R}$$

$$Precision = \sqrt{\frac{\sum_{1}^{n}(S-R)^2}{n}}$$

$$Relative\ precision = \frac{\sum_{1}^{n}|S-R|}{\sum_{1}^{n}(R)}$$

Where,

S = Sensor Value

R = Reference Sensor Value

n = number of samples.

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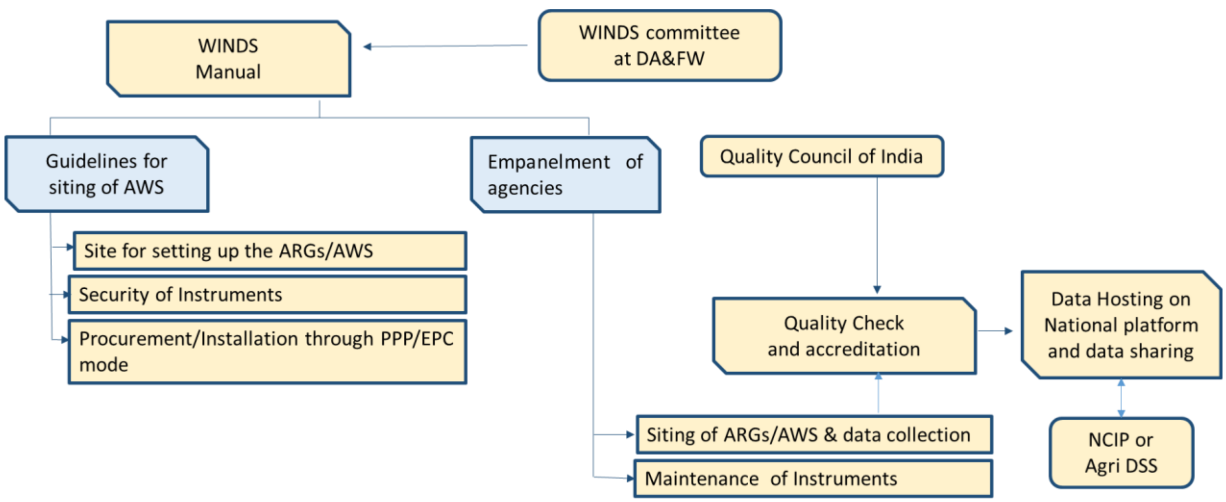
Chapter 11

WINDS realisation framework

The proposed framework for realisation of WINDS is given in Figure below. The current manual provides guidelines for establishing the network of weather stations and collecting the data. The states are expected to empanel the agencies for the task and select a suitable agency to complete the steps involved in setting up instruments and necessary follow-up activities. Quality Control of India undertakes the responsibility of accreditation to the data, as per the guidelines to be provided.in advance. The data will be hosted on a centralised platform and shared to States and insurance companies.

Fig. Realisation of WINDS objectives



Annexure-I

Standard Operating Procedure for AWS Installation/Deployment

Pre-Deployment Check list:

1. Ensure that, you have received all the required material (sensors, DL, Batteries, Solar Panels, accessories, hardware, software) for the installation and are in working condition.
2. Ensure that the material you have received for the installation is verified and tested by research and development team and confirmed sensors reasonability.
3. Ensure that, you have received Factory Acceptance Test certificate (FAT) along with the material.
4. Ensure that, you have received site survey report.
5. Ensure that, you have received the SIM card of the same service provider which was recommended in the site survey report.
6. Ensure that, the battery received with data logger is fully charged.

Deployment Check list

1. Confirm that, the site is as per the site survey report and fulfilling the siting norms. Report if not.
2. Ensure that, the mounting mast is upright and making 90° angle to the ground.
3. Confirm that, the mounting pole of TBRG is upright and making 90° angle to the ground and its height is 30 cm above from the ground.
4. Identify the North direction of the site, make mark on the mast as well as on the mast foundation.
5. Install anemometer at the top of the mast (i.e 3 m from the ground).
6. Ensure that, the North direction marking on the sensor is facing towards the North direction.
7. Ensure that, temperature and relative humidity sensor (with radiation shield) is installed at the height of 1.25 to 2m from the ground surface.
8. Install TBRG on the mounting pole. Ensure that, the connecting cable of the TBRG goes through the conduit pipe and base of the TBRG is above 30 cm above the ground.
9. Mount the solar panel at suitable height with suitable angle along the South direction so that it can work with optimum efficiency.
10. Mount the Data Logger at suitable height without disturbing sensors position.
11. Connect all the sensors and solar panel to the data logger.
12. Check the functionality of all the sensors, DL and Solar Panel and communication of the station to the server.

Post-Deployment Check list:

1. Check temperature and humidity readings and compare with reference sensor. Take five set of observations for the comparison.
2. Check and compare wind sensor's reading with reference sensor. Take five set of observations for the comparison.
3. Ensure that, the buckets lock/tie is open, and its movement is free.
4. Ensure that, the levelling bubble of the TBRG is at center position.
5. Ensure that, both the buckets are tipping on accumulation of 5 ml of water in it.
6. Ensure that, after every tip data logger shows 0.25 mm of rainfall on the DL screen/display.
7. Ensure that, all the cables are neatly tied with the help of cable-tie and adhesive tape.
8. Generate Site Acceptance Test Certificate (SAT) based on the comparison of on-site sensors against reference sensor and submit the report to the server.

Submission

1. Submit the installation report to the server.
2. Keep the station under observation at least 24 hours. If found okay register the station on Mahavedh Portal.

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Annexure-II

Standard Operating Procedure for ARG/AWS Maintenance

For faster and quicker movement and response spare parts sub-inventory need to maintain at cluster level. Ensure that, you are always maintaining 10 % of the spare parts of total cluster in your inventory.

Preventive Maintenance:

Preventive maintenance should be done once in every month.

Corrective Maintenance/ Trouble Shooting:
Corrective maintenance should be on call there is no constraints. Corrective maintenance must be attended within 3 working days from the day of fault/breakdown reported.

For both the type of maintenance following guidelines / checklist should be followed.

Pre-Maintenance Check List:

1. Ensure that your mobile battery is fully charged.
2. Ensure that you have carried toolbox containing all types of maintenance tools.
3. Ensure that you have understood the breakdown issue and associated activities.
4. Ensure that you are carrying required spare parts and accessories as per the breakdown call.
5. Ensure that, you have looked at station's history of the station to be visited.

Maintenance Check List:

1. Note down and report the overview of physical inspection of the site on i) hanging of wires, theft/damage of equipment, grass, civil and fencing status, new obstacle raised if any)

Sensors:

1. Ensure that north marking/arrow is aligned to the North direction of the station.
2. Check wear and tear of the anemometer.
3. Check anemometer connection and ensure its functionality.
4. Check the anemometer cable, if required change the cable.
5. Clean the anemometer connectors, connect to the DL and ensure its functionality again.
6. Ensure that the ATRH sensor is mounted at the height of 1.25 to 2 meter from ground
7. Check the connection of the ATRH sensor and ensure its functionality.
8. Check the ATRH cable. If required change the cable.
9. Remove ATRH sensor and clean the radiation shield.
10. Check filter cap of ATHR sensor. if dust accumulated on it change the filter cap. (Filter cap should be replaced after every three months.)
11. Clean the sensor gently and remove the dust and dirt accumulated on it.
12. Clean the ATRH connectors.

13. Ensure that you are installing ATRH sensor at the height of 1.25 to 2 meter from ground.
14. Check the functionality of ATRH sensor.
15. Check and compare ATRH sensor's instantaneous measurement with the Whirling Psychrometer's measurements. Take 3 to 5 sets of observations for the comparison. Report all the measurements in Designated mobile application.
16. Inspect the TBRG and comment on:
    i) Position of the TBRG: Whether it is upright or tilted/leaned
    ii) Whether any debris accumulated in the funnel of the TBRG.
    iii) Whether the bubble of the level meter is at the center.
    vi) Rusting observed on any part of the TBRG.
17. Remove the debris from the funnel (if observed any) and clean the funnel.
18. Remove the rust (if observed any) with the help of spray WD-40. Apply anti rust spray/oil/grease on the rusted part.
19. Ensure or adjust the level meter bubble at the center.
20. Ensure that the buckets are moving freely
21. Calibrate the bucket with the help of syringe and ensure that both the buckets are tipped on 5 ml volume of water.
22. Ensure that the DL records and show 0.25 mm rainfall after every tip.
23. Check the TBRG cable if required change the cable.
24. Clean the TBRG connectors and ensure the functionality of the TBRG.

Power Unit:

1. Check solar panel connections.
2. Check and report solar panel voltage.
3. Check battery connection.
4. Check and report battery voltage.
5. Check and report battery output terminal voltage.
6. Clean and mount the solar panel.
7. Ensure that the solar panel is mounted on South direction and with proper angle.

Communication unit:

1. Check and report DL IMEI.
2. Check and report CCID of SIM.
3. Check antenna connection.
4. Remove SIM card and clean the slots softly.

Post-Maintenance Check List:

1. Ensure that all the screws are tightened properly.
2. Ensure that all the clamps are tightened properly.
3. Ensure that all the cables are neatly tied with cable tie or adhesive tape.
4. Ensure that you have selected correct location name from the drop-down list of the designated mobile application. Please reconfirm it.
5. Ensure that you have correctly reported material requirement.
6. Ensure that you have filled comment section of the application correctly and precisely.
7. Ensure that you have filled log card properly.
8. Check the stations communication with the server by reporting to your reporting

manager.

Submission:

1. Ensure and confirm that all the fields in the maintenance report are filled completely.
2. Submit duly filled maintenance report to server. (*Server will not accept partially filled report*)
3. Site Leaving Permit (SLP) will be generated in the application after the successful submission of the maintenance report.
4. If it is not generated automatically, ask your reporting manager to generate the permit for leaving the site. Without this permit field engineers are not allowed to leave the site.

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