STRENGTHENING HYDROMETEOROLOGICAL MONITORING

EARLY WARNING SYSTEMS AND CLIMATE SERVICES IN COLOMBIA:
THE IDEAM, A SUCCESSFUL CASE IN LATIN AMERICA

IDEAM
Instituto de Hidrología,
Meteorología y
Estudios Ambientales

Strengthening Hydrometeorological Monitoring,

Early Warning Systems and Climate Services in Colombia: The IDEAM, a success story in Latin AmericaLatina

Over the past five years, the Institute of Hydrology, Meteorology and Environmental Studies of the Republic of Colombia (IDEAM) has made a revolutionary technological breakthrough, which results are notorious throughout the country, obtaining benefits in terms of improved data, information of quality and in real time, enabling the prevention and alert of communities at risk, of the occurrence of extreme events, as well as strengthening of cooperation ties with the main international agencies and organisms, and development banks.

In recent years, the recurrence of extreme phenomena of climatic variability has demanded from IDEAM an increasingly timely response in forecasts and weather forecasting, based on early warnings associated with effective decision-making on topics of landslides, floods, forest fires, flash floods and slow growing.

The phenomena of climatic variability as "El Niño" and particularly the La Niña 2010-2011, which generated a national emergency situation never before seen in the country, affecting nearly 765 municipalities in Colombia, accelerated the technological strengthening for monitoring and hydrometeorological risk assessment.
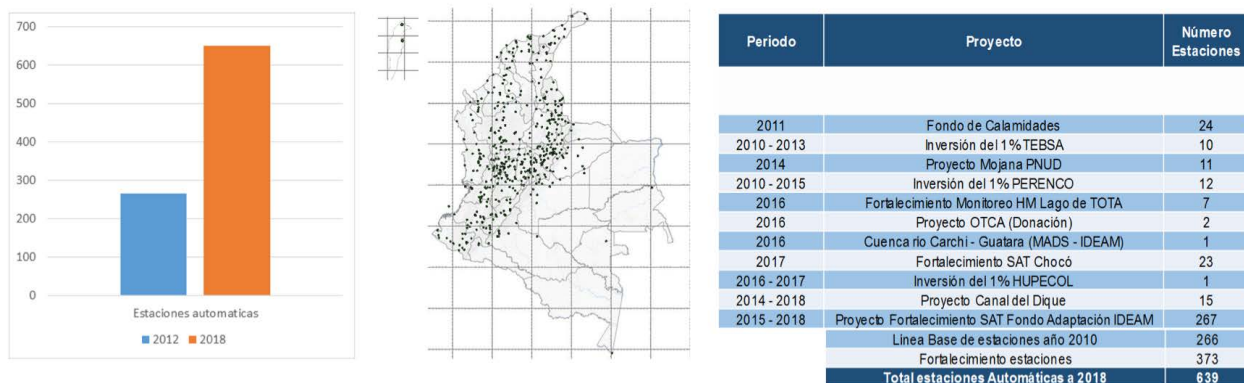
Likewise, the provision of Climate Services was improved, in line with international guidelines framed by the World Meteorological Organization (WMO), promoting the definition of actions and strategies in the National Framework of Climate Services that extends to the high government, the institutions, the economic sectors and the community in general. This strengthening is expressed in the improvement of the user interface platform; Climate Services Information Systems; Observation and Monitoring; research, modeling and prediction, and capacity development.

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1. Modernized observation and measurement systems

a) Increase of the hydro-meteorological network in real time

As a result of strategic alliances with different entities, it has been achieved in recent years to increase the hydrological and meteorological monitoring in real time, going from 266 (2010), to 639 automatic hydrometeorological stations in 2018.

Periodo	Proyecto	Número Estaciones
2011	Fondo de Calamidades	24
2010 - 2013	Inversión del 1% TEBSA	10
2014	Proyecto Mojana PNUD	11
2010 - 2015	Inversión del 1% PERENCO	12
2016	Fortalecimiento Monitoreo HM Lago de TOTA	7
2016	Proyecto OTCA (Donación)	2
2016	Cuenca río Carchi - Guatara (MADS - IDEAM)	1
2017	Fortalecimiento SAT Chocó	23
2016 - 2017	Inversión del 1% HUPECOL	1
2014 - 2018	Proyecto Canal del Dique	15
2015 - 2018	Proyecto Fortalecimiento SAT Fondo Adaptación IDEAM	267
	Línea Base de estaciones año 2010	266
	Fortalecimiento estaciones	373
	Total estaciones Automáticas a 2018	**639**

Growth of automatic stations network in recent years

b) Increase in height network

Since 2015, daily radiosondes have increased in the country, with the consequent improvement in the resolution of the numerical models for the prediction of time at regional and local level. To the four radiosondes that were made in San Andres, Bogota and Leticia, the radiosonde stations of Cali, Marandua (Vichada), Barranquilla and Bucaramanga were added in 2017, for a total of seven points in the country where a daily radiosonde launch is made. This year, the incorporation into the network of one more point in the city of Pereira is projected.

Red de estaciones operativas año 2016

Red de estaciones operativas (7) año 2018

Growth in the radiosonde network in the past 3 years

c) Implementation of the National System of Meteorological Radars

The consolidation of the National Meteorological Radars (SNRM) incorporating to the IDEAM four Doppler C–band weather radars with dual polarization installed in Barrancabermeja, Guaviare, Cerro Munchique (Cauca) and Carimagua was achieved (the last two scheduled for the second half of 2018). In addition, the necessary channels were established to obtain the data of the C-band radars installed by Civil Aeronautic (San Andres, Corozal and Bogota), the Metropolitan Area of the Aburra Valley (Medellin), in addition to the installed X-band radar in a specific area of Bogota, Capital District.

That is to say, that at present the SNRM has data from nine radars for the country, under the same viewing platform. This innovation means a new perspective for the country from the point of view of the resolution of forecasts and alerts, since IDEAM did not have this technology five years ago.

*Meteorological radars installed and running tests*

d) Management for the acquisition of GOES16

As part of the institutional progress in terms of disaster risk management in the country, several actions have been taken to obtain data from the GOES satellite16. Initially through GEONETCast, way by which we have been able to obtain information from nine of the 16 channels available by satellite. This information has been taken to the institutional visualization system and is the basis for monitoring and tracking analyzes.

In addition to this, the management has been carried out to obtain the receiving antenna of the GOES16 satellite, with which we can have the total availability of the 16 channels; the installation of the said antenna is projected to take place within the next three to four months.

e) Monitoring real-time thunderstorms

With regard to electrical storms, taking into account the increasingly urgent need to monitor the occurrence of this meteorological phenomenon and in the same time incorporate it into the analysis of forecasts and issuance of alerts, since 2015 we have been hiring the supply service of Lightning activity information, historical and in real time, which is incorporated into the analysis and forecast bulletin. Since then, the data coming from this service have also been integrated into the visualization system based on the issuance of alerts.
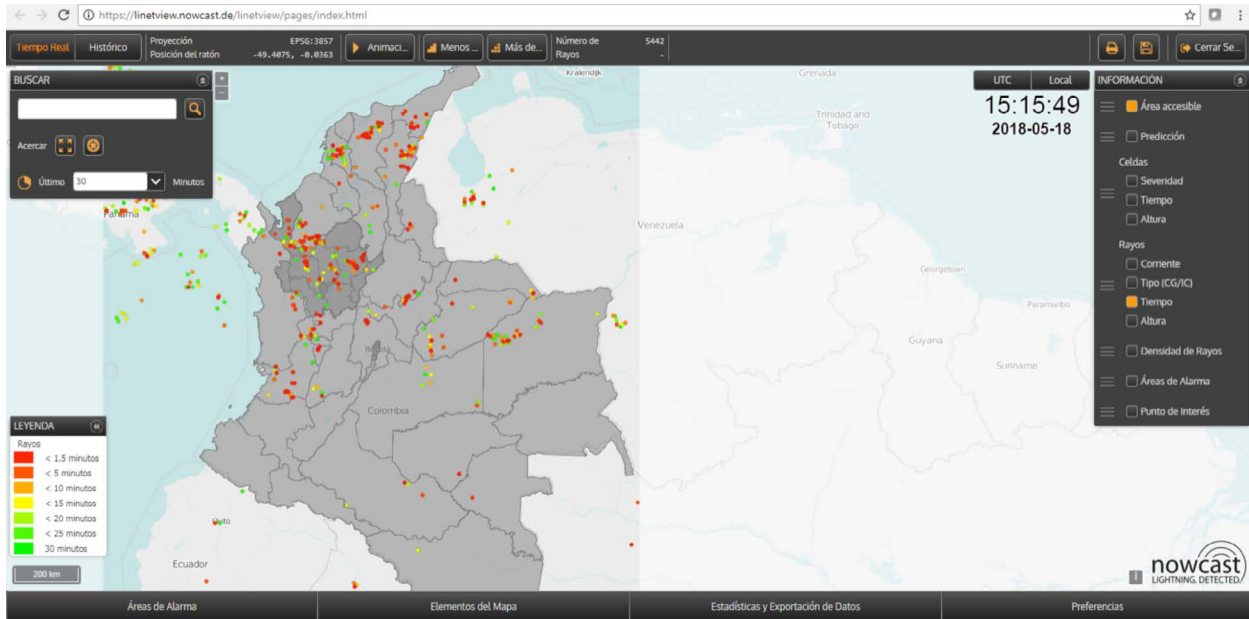
LinetView Display System - Monitoring of Electrical Discharge in real time. Source: Keraunos

2. Renewal of Meteorological Modelss

a) Increase in reported stations to the Global Telecommunications System (GTS)

The strengthening of the meteorological network referred to, made possible to advance in the data reporting to the World Telecommunications System (GTS) of the World Meteorological Organization (WMO), going from 27 to 204 stations, with data in time resolution in BUFR format (Binary Universal Form for the Representation of meteorological data), and this has been welcomed by the international scientific community.
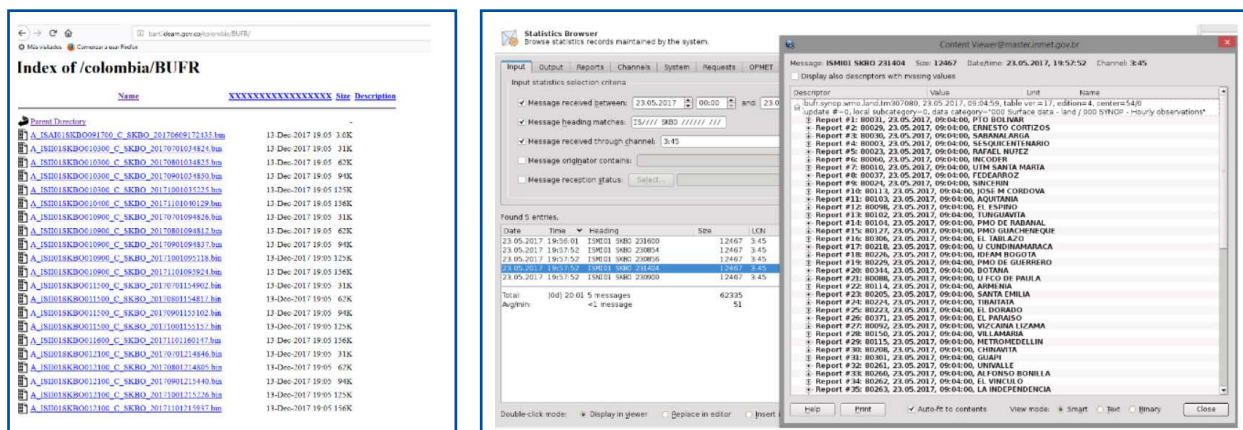
On the left, BUFR password on the IDEAM portal. On the right, reception of the BUFR code in the Global Telecommunications System for 204 automatic stations

b) Improvement in time models

IDEAM incorporated the latest version of the WRF model (Weather Research and Forecasting), which allows to assimilate data from automatic stations that report in quasi-real time (delay no greater than 40 minutes within an hour) to improve the initial conditions of this type of models. For 2019, data from the meteorological radars will be integrated.
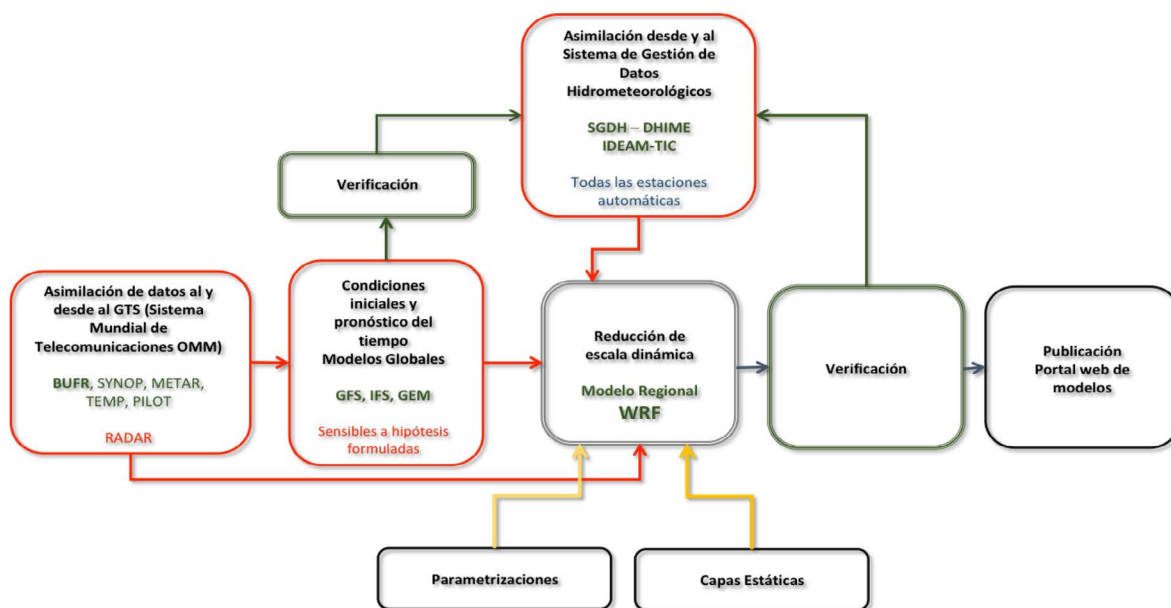
New implementation scheme to run time models considering data assimilation to, and from, the Global Telecommunications System (GTS)

Since 2015, the Service of Forecast and Alerts office generates and displays weather forecast products based on the model of the European Center IFS. This model is an essential part of the analyzes that forecasters use on a daily basis about the state of the atmosphere for the next hours and days; supporting operative decisions of early warnings on specific issues of precipitation, temperatures and winds.

c) Improvement in climate models

Regarding to seasonal prediction models is important to note that IDEAM has implemented both dynamic and statistical models, performs seasonal forecasting with analysis of the synoptic situation of the previous month, seasonal prediction based on similar years under the hierarchical Cluster methodology, seasonal calendar prediction models made by IDEAM and review of other outputs of different climate forecast centers.

1
SEGUIMIENTO DEL ÚLTIMO AÑO Y LOS ÚLTIMOS MESES

2
ANÁLISIS SITUACIÓN SINÓPTICA DEL MES ANTERIOR

3
ANÁLOGOS 1981 - 2017

4
CORRIDA DE MODELOS ESCALA NACIONAL IDEAM

ESTADÍSTICO DINÁMICO

5
SALIDAS DE MODELOS INTERNACIONALES

ESTADÍSTICO DINÁMICO

Structure of the seasonal prediction system in IDEAM

In the dynamic modeling, the prediction for the anomaly of the average temperature (in °C) and the percentage anomaly of the precipitation (in%) was implemented from the data available on the website of the North American Multi-Model Ensemble (NMME) whose assembly contains two versions of the Canadian model, the model of the Geophysical Fluid Dynamics Laboratory (GFDL) of the NOAA, the model of the National Aeronautics and Space Administration (NASA) and the CCSM4 of the National Center for Atmospheric Research (NCAR).
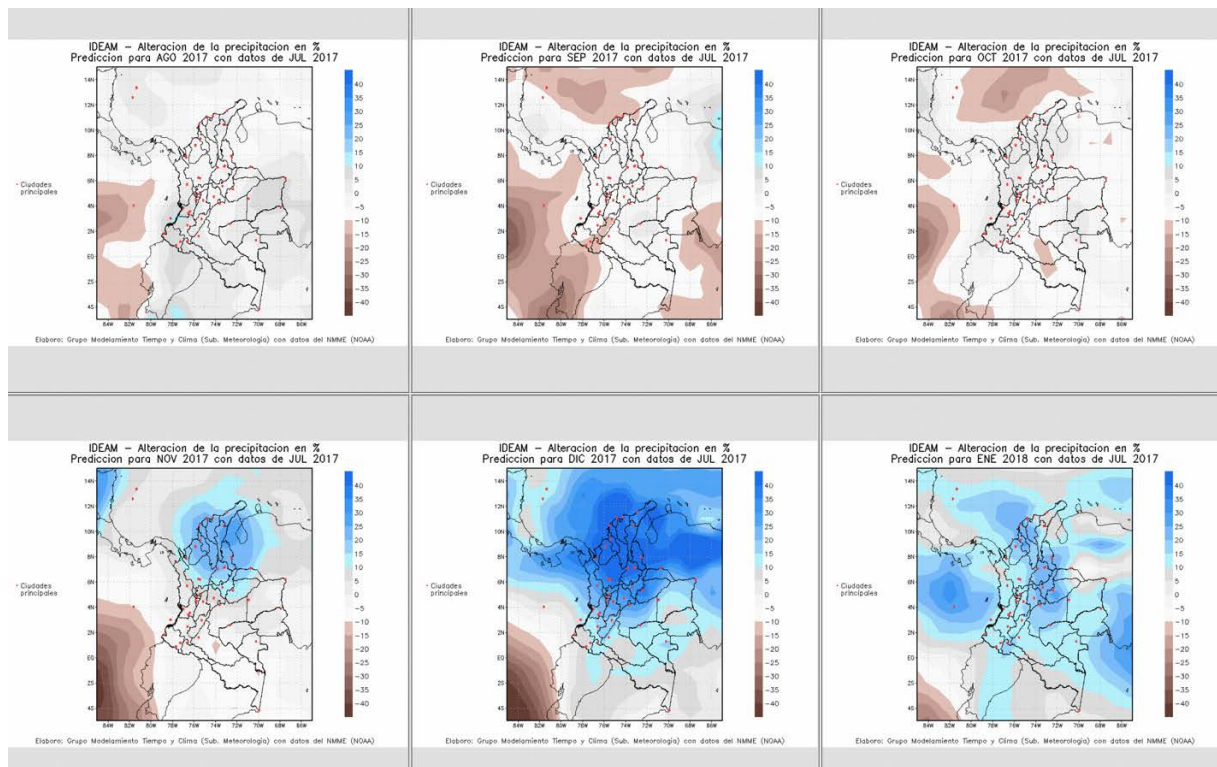

Expected seasonal forecast from August 2017 to January 2018 with data from NMME

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For statistical modeling, the canonical correlation model is used using the Climate Prediction Tool (CPT) developed by the International Research Institute for Climate and Society (IRI) of Columbia University, US. With this, we have been making predictions of precipitation and maximum and minimum average temperatures officially since 2010, in the short and medium term (one and three months).

Line of work in statistical modeling of seasonal prediction developed in the last 5 years

It is important to indicate that since 2016, precipitation is forecasted with satellite data derived from the database of the Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) and in this way seasonal forecasts are obtained with a spatial resolution of 5.5 kmX5.5 km.


~ 38.000 puntos en el país.
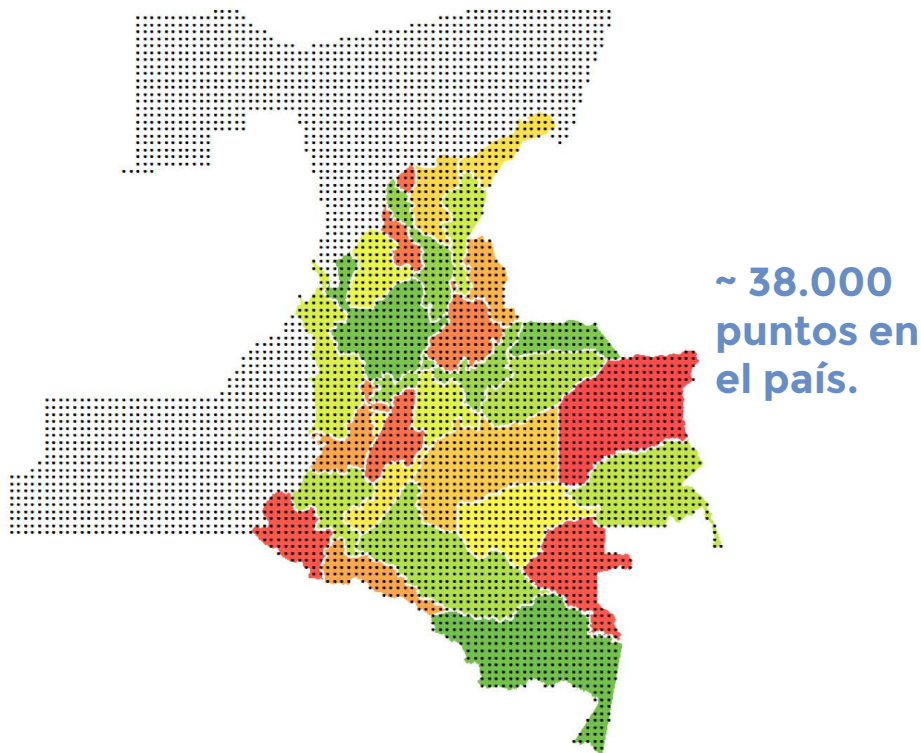
CHIRPS data grid for the national territory

3. Display platforms

With the entry of radar information to the operational scheme of the Forecasting and Alerts Office and the increase in the temporal availability of GOES16 satellite data, as well as the information of the lightning network, the hydrometeorological station network and new sources of information, the Service of Forecast and Alerts office has been strongly strengthened.

This has been accompanied by strengthening the group of professionals that from automated processes, undertake continuous improvement of the organization, integration and production of textual and graphical outputs for optimally use of existing applications such as SmartMet[1], GEONETCast and FEWS[2].
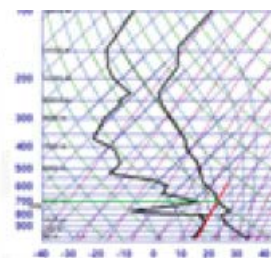
In the same way, it is increased the capacity to use GIS tools for the generation of web products and mobile applications, based on the main use of free software tools, with the aim of enabling the Institute the autonomy and scaling of the applications that are built.
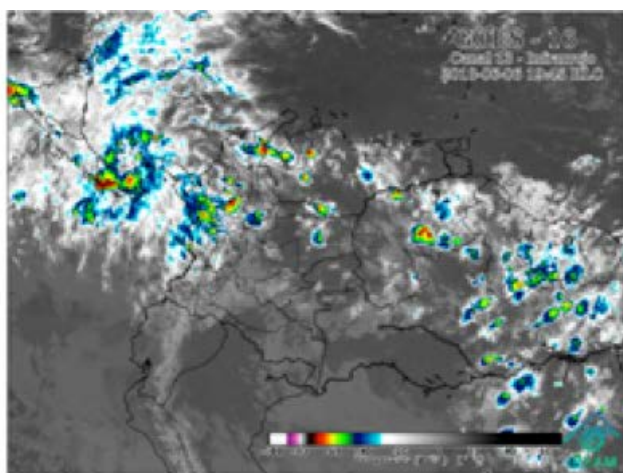

Display Platforms

The SMARTMET tool, developed at the Finnish Meteorological Institute (FMI), allows integrating data from meteorological models, observations, satellite images and scripts for forecasting adjustments among other functionalities.

1. SmartMet is a working platform for analysis and edition of forecasts of Finnish origin donated by the Finnish Meteorological Institute (FMI), which allows under a single visualization to analyze and make decisions regarding forecasts based on the 5 models that are currently operational inside the Office of Forecasts and Alerts.
2. FEWS is the hydrological analysis work platform. This tool of Dutch origin was donated at the time by DELTARES.
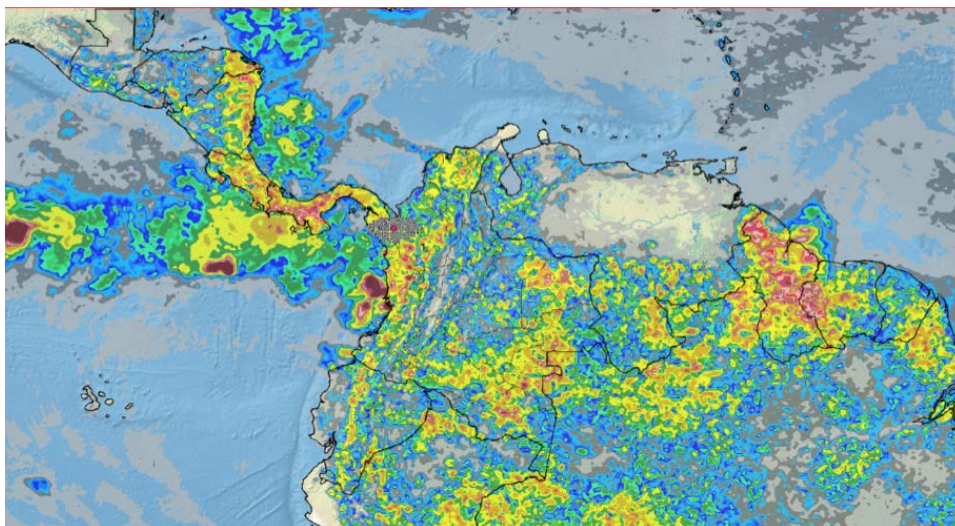
*Graphical output of the European Model data incorporated into SmartMet case that
applies to the variable of surface precipitation*

4. Support and development of thematic applications of Desktop, Web and Mobile

Regarding the WEB environment, from the Service of Forecast and Alerts office, applications such as the operational viewer have been designed, which has been conceived as a light and flexible tool, which allows presenting information in real time, combined with climatological information, which also has the ability to adapt dynamically to the needs of day to day.

Among some viewer functionalities, there is access to IDEAM observation cameras and other institutions (SGC, SIATA, etc.), temperature and precipitation information, deployment of landslide and hydrological alerts, visualization of forecasts generated by meteorologists in SmartMet, satellite images, radars and electric discharges in an animated way, among others.
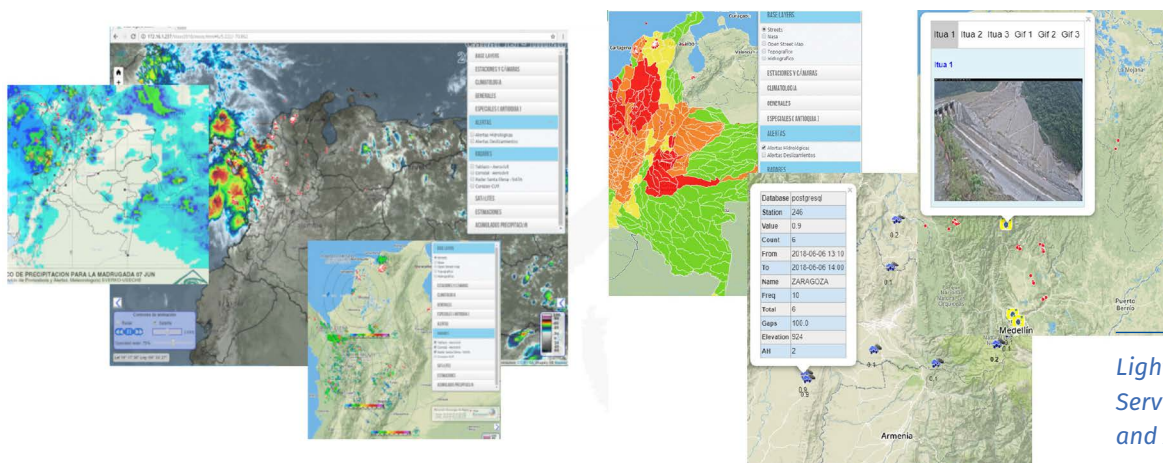
*Light viewer of the
Service of Forecast
and Alertsoffice*

The hydrological forecasting platform FEWS-Colombia, incorporated in IDEAM since 2012 as part of an international cooperation with the Dutch government, allows integrating information from models generated in the National Modeling Center (HBV, HEC-RAS, HEC-HMS, Mike 11 and Sobek in addition to statistical models, multiple regression models, ARMA models and mobile media models) and regional models generated by environmental authorities.

The Magdalena River is currently covered with this platform from Betania to Magangue, the Cauca River in the Salvajina to Victoria section, the Meta River between Puente Lleras and its confluence with the Arauca River, the San Jorge River, the Lebrija River, the Risaralda River, Bogota in its upper basin (with hourly resolution). Integrates precipitation estimating information from satellite images at the NOAA and JACSA time scales.

Nowadays, its Web version allows to display information of the last eight days by users, dynamic maps and dynamic reports of levels and flows in a period of up to six months. Approximately 2000 users access this platform every quarter with additional queries from other countries. It also integrates the forecast of rain of the following three days in a resolution of 8 km for the whole country.

Integration of data in FEWS Colombia (http://fews.ideam.gov.co/)

5. Climate Services

In the context of the WMO Climate Services initiative, IDEAM has been working in an articulated manner with the following sectors:

Agriculture: Once a month, a climate prediction analysis meeting is held with more than 25 industry associations, led by the Ministry of Agriculture and Rural Development, issuing a bulletin that has been called "Agroclimatic Bulletin", a technical document with recommendations by crop.

Health: In the same way as the previous sector, IDEAM holds a meeting with the Ministry of Health and its affiliated institutions, with the purpose of building the "Bulletin of Climate and Health" on a monthly basis.

Risk: IDEAM is part of the knowledge committee of the Risk Management Unit of the country, where is delivered daily the evolution and behavior of the hydrometeorological conditions at the regional level,

state and behavior of the main early warnings of each of the municipalities of the country.

Mining and Energy: A bi-monthly meeting is being held with this sector, with the purpose of discussing climate prediction and thus taking the forecasts for the operation and management of energy generation reservoirs.

Transport: We provide information on the state of the main river arteries for navigation on a daily basis and with the same periodicity a report on the main road axes due to the threat of landslide.

It should be noted in particular, that in March 2018 IDEAM gave to each of the productive sectors of the country, a new version of the Climate, Radiation and Wind Atlases that already glimpse as an exceptional planning tool.

In this way, with successful and determined investments represented in clear undertakings and technological improvements, IDEAM is projected as the leading institution in the region for the provision of climate and hydrometeorological services, while at the same time shares its progress with peer entities from other countries in the region with which it manages information and knowledge or supports its experience when they require it.

6. Massive dissemination of information

a) Sending information via email / publication on web page

Taking into account our institutional mission, shipments of the different generated bulletins are made with a periodicity that goes from 4 hours, to the monthly, as it is visualized below:

DOCUMENTS	PERIODICITY
Hydrometeorological conditions bulletins	Every 4 hours
Daily technical report	1 per day
Hydrological reports	2 per day
Landslide and fire hazard reports	1 per day
Agrometeorological Bulletin	1 per week
ENSO Phenomena Reports	1 per month
Climate prediction bulletin	1 per month
Extraordinary alert report	When the occasion arises

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This information is sent to all entities of the National System for Disaster Risk Management (municipal mayorships, governorates, civil defense, military forces, red cross, among others), as well as regional autonomous corporations.

b) Implementation of the Common Alert Protocol (CAP)

Taking into account the initiative of the WMO for the mass dissemination of information, since 2013 our country has implemented the system of mass dissemination of alerts through the platform provided by Google for this purpose. It is noteworthy that Colombia has been a pioneer in Latin America in the subject, after it was already in operation in countries like Japan, Taiwan, Australia and the United States.

Google Alerts Publics is Google's platform for the dissemination of emergency messages, such as evacuation notices that are made in the wake of a hurricane. The main objective is to disseminate the official alert information when a search is done on Google and Google Maps.

In a joint alliance between IDEAM and the National Unit for Disaster Risk Management (UNGRD), daily alerts that have been established by the IDEAM according to the analysis of current hydrometeorological conditions, are placed on a predetermined server, from where Google Alerts consumes the services arranged there, giving rise to the fact that all current alerts by our institute are within the reach of any person who displays the Google search engine on the web.

c) Implementation of the *Mipronostico* application

In an institutional effort to try to arrive in different ways at all user levels, IDEAM made an application for smart mobile phones. This APP, available in the virtual stores of Android and IOS, today has more than 200,000 downloads and where continuous information is obtained from 5-day forecasts for all the municipalities of the country (a little over 1100).
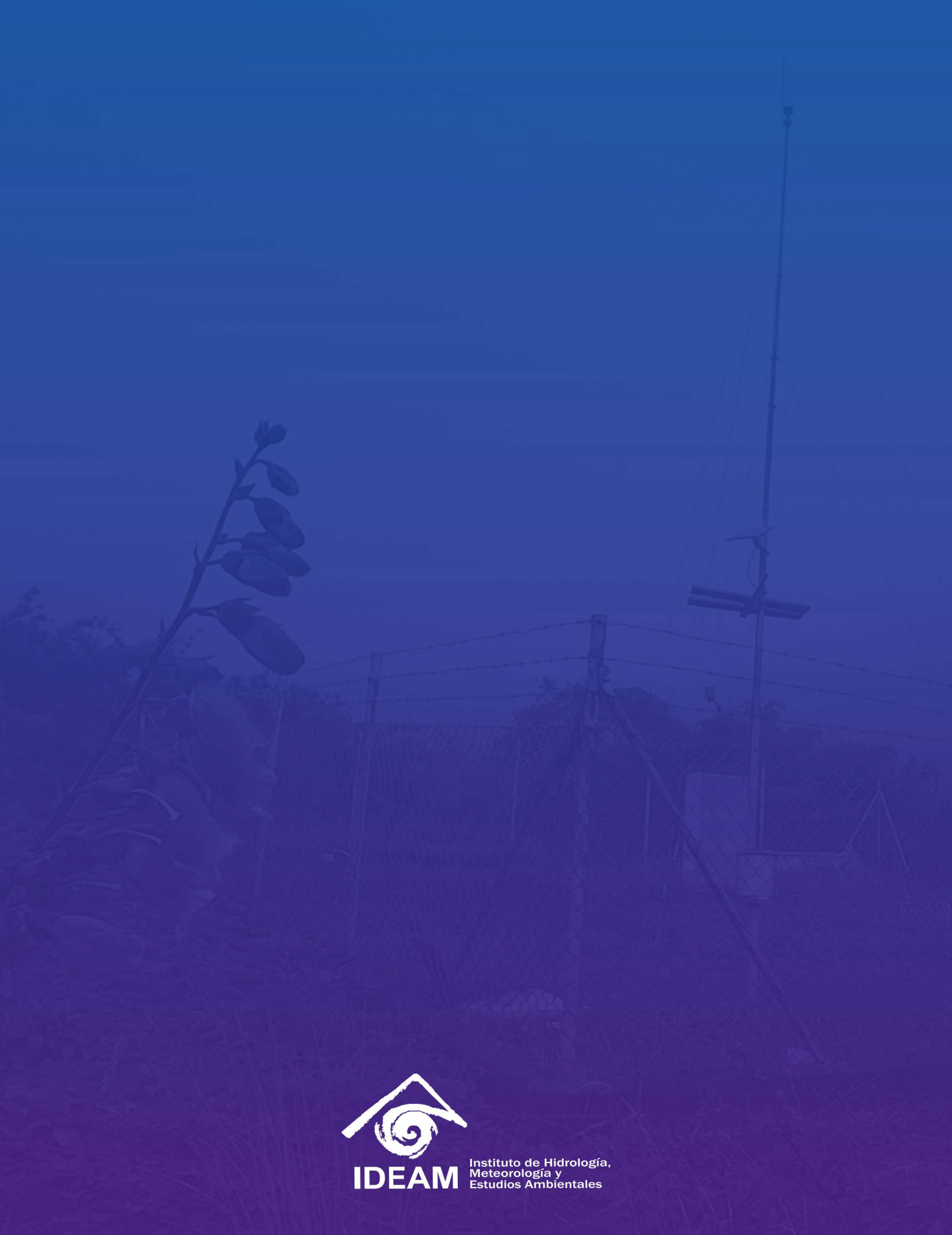
The APP includes ray alerts every 30 minutes, in addition to the alerts associated with flood hazards, sudden floods, earth slides, fires of vegetation cover and frosts. Additionally, deforestation alerts have been included as a major novelty within the APP, which are updated every three months, given the resolution of this issue.

d) Dissemination of information through social networks

Given the great potential of the Social Networks of the institute in the dissemination of information, it is important to point out the growth that IDEAM has had in its Twitter, Facebook and Youtube accounts. Today the balance is the following:

- **Twitter: 248.401 followers**
- **Facebook: 58.914 followers**
- **Youtube: 2.044.892 (display time)**

Through our accounts we constantly issue the current hydrometeorological conditions, as well as the alerts or threats due to the possible occurrence of events of hydrometeorological origin.

IDEAM