First tentative logo of WARN
Not yet Approved by the network

"International Workshop on Advances in Operational Weather Systems for Fire Danger Rating"

Report

Prepared by
Cheikh MBOW
WARN

West african regional network secretary

WARN was represented to the “International Workshop on Advances in Operational Weather Systems for Fire Danger Rating” from 14-16 July 2008. The link with the West African network is the development of a prototype that may be implemented in our sub region. This prototype has been initiated during the Accra meeting held in November 2007. The workshop has been hosted by Natural Resource Canada-Canadian Forest Service and the GOFCGOLD Project Office, and was held at the Northern Forestry Centre, Edmonton, Alberta Canada. All the continents have been represented by 72 participants.

Workshop rational

Efforts to develop fire danger rating systems have been driven by a concern about large fires, particularly those burning out of control and endangering human lives and property. Fire’s influence on and response to the changing global climate and, on a smaller scale, fire’s effects on regional and local air quality have become international issues. As countries have sought to improve public health and safety, wildland and agricultural burning have attracted increasing attention as sources of concern and become the target of regulatory attention. Fires burn in vegetative fuels largely as a function of weather conditions and fuel characteristics. Meteorological data are critical to forecasting the potential for fires to get started and for their behaviour once started. A third area of meteorological data needed relates to predicting smoke trajectories and dispersion. The World Meteorological Organization (WMO), the Canadian Forest Service (CFS) and others, have addressed this issue over the years by developing tools to evaluate and predict the effects of weather and climate on fires and their potential. One of the key WMO focus areas addressed from 2008-2011 is Agrometeorological Aspects of Sustainable Agricultural Development. A key performance target is the production of operational guidelines for fire weather agrometeorology by 2009. It is with this background that the CFS, WMO, and panel for Global Observation of Forest and Land Cover Dynamics (GOFC-GOLD), and in collaboration with a number of other agencies have organized the International Workshop on Advances in Operational Weather Systems for Fire Danger Rating in Edmonton, Canada from 14 to 16 July 2008.

Objectives of the Workshop

The workshop will review operational methods used in fire danger rating (FDR) systems from around the globe and discuss new developments in system design and potential enhancements.
Workshop sessions include:

1. Overview of FDR approaches and role of weather information in fire management including concepts and terminology, purposes/requirements, limitations, etc.
2. Reports on operational and prototype weather-based FDR systems from around the globe, including North America, Europe, Russia, Southeast and East Asia, Australasia, Latin America, Africa, etc.
3. Opportunities for FDR system enhancement with break out groups on:
    - Weather observations and networks (access and adequacy of in situ data, use of remote sensing, etc.)
    - Data management (collection, storage and retrieval, spatial processing and display, dissemination)
    - Weather analyses (fire weather normals, short & medium term weather forecasts)
    - Approaches to defining and evaluating fire danger levels (calibration, validation)
    - Additional indices of fire danger (live vegetation, curing, soil moisture, human behavior, etc.)
    - Smoke forecasting and monitoring (emissions, dispersion, etc.)
4. Operational guidelines for weather-based FDR including:
    - Discussions with provincial and national fire information centres

- Review of the WMO Guide on Agricultural Meteorological Practices

Minutes of the workshop

Presentation from Martin Alexander (Canadian Forest Service)
History and legacy of FDR in wildland fire management

Defined Fire danger as A general term used to express and assess fixed variables and factors of fire environment that determine the ease of ignition, rate of spread, etc. Therefore FDR requires an integration of individual factors. The aim being a set of Fire danger index which are quantitative indicators of one or more facet of fire expressed in relative terms. The presentation revisited largely the history from the 1960s with the work of Countryman' 1966 concept of FD. These studies expressed FD as very much connected with the number of fires in a region and the subsequent damages after fire. Fire impact has been therefore linked with the Risk of ignition and size which influence there source damage rate. The ignition source and the fuel characteristics was part of the conceptual model developed during that period.

Earlier there was two approaches of fire management: one using a formal system another with versus unformal system
Formal = accuracy assessment, calculate parameters, keep of records, management based on knowledge
Unformal: estimation, empirical, no climate record kept, decision based on experience and vary according to individuals

Some of the FD precursor developed a wise approach warning manager to avoid being gamblers but managers, and avoid thinking that a good system of FD measurement is the answer of all fire control frameworks.

The key note presentation has pointed so far various application of FD

- prevention planning
- preparedness planning
- detection planning
- initial attack dispatching
- formulate suppression plans on active fire
- evaluation of fire behaviour
- escape fire situation
- prescribe fire
- fire and fuel management modelling and planning
- fire behaviour training
- wildland fire research

Another pioneer in FD estimation was Harry Gisborne (American Pioneer in Forest Fire research). This agent of US forest service developed a fire Danger Meter in US in a tenure position at USFS. Later, James Wright and Herbert Beall in the 1920s helped to push the concept forward. The elements they worked are still very valid.

The Australian branch of fire studies developed surface fuel studies in the 1950s with Alan McArthur and Harry Luke ho used grass land and forest biomes of Australia to set a FDR. Basically they developed the so-called Biome drying index as a fire danger meter, considering wind and meteorological factors as important in fire spread…

FDRS can be conceived in various scales and the history of the discipline has followed the following steps:

- local level (starting in the early 1930s)
- Regional level (up to mid 1960s)
- National level (late 1950s and achieve at the late 1970s)
- Global level (in the 1970s, revitalized interest in 2005)

Most important issues in FDR

- What to measure?
  - Fuel (quantity, moisture and condition, size and shape, depth and height, arrangement of fuel). Fuel moisture for different fuel types. Vegetative state conditions related to changes in the understory and overstory of the above ground biomass
  - weather characteristics (wind speed and direction, relative humidity, air temp, rainfall amounts and duration, cloud cover, atmospheric instability)
  - Topography
- When to measure?
  - Variety depending to ecosystems and phenology
- where to measure
  - Open exposure standard vs in stand exposure. Open areas are more risky as the understory is very developed (Africa)
- How to measure?
- How to integrate the measurements?
- How to apply danger ratings?

Parameters to measure

a. Fuel characteristics ‘quantity, moisture and conditions, size and shape, depth and height, arrangement)
b. Weather characteristics (wind speed and direction, relative humidity, air temperature, rainfall amounts and duration, cloud cover, atmospheric instability)
c. Topography (slope steepness and aspect, elevation, configuration, barriers to fire spread)

Session 2: Experience from other regions

FDRS in Argentina: Maria Dentoni and Fernando Epele

What is the need of FDRS in Argentina?

- Coordinates the surpression activties
- Standardazied procedure
- Develop national training
- Development of new technologies
- Based in the CFFDRS
- Development started in 2000

Fuel type has been mapped (start point) and weather stations set in place. Next steps will be the adjustment of codes and indexes in various ecosystems; to develop models for interpretation of FD index; generate danger maps; extend the system in the country.

FDRS in Croatia: Vucetic M

They used the Canadian Forest fire weather index and adpted it ti the country

FDRS in China

The project started in 1994 using the Canadian FWI (fire weather Index)

- Problems: more than 50 methods of FD in China
- Lack of fundamental research on fuel moisture and fire behaviour
- Lack of calibration of existing methods
- Need of high tech to be used in FDRS
- Test of CFFDRS

FDRS in EU: Andre Camia EU andre.camia@jrc.it

The JRC approach, satellite base studies for active fire historical footprints but also as a surrogate for curing rate history. The system is made for EU for decision making. Fire Weather Index has been developed in standardized base.

FDRS in UK: Karl Kitchen

The UK FDRS is based on the Canadian FWI which is good for a wide range of situations. They generate information on risk due to drought and risk due to wind meteorological conditions. The aim is to avoid access to country side when fire danger is high. The information is disseminate through a web site.

FDRS in Indonsia: Guswato and Srar Albar

The Objectives of the FDRS in Indonesia are

- Prevention, monitoring and mitigation of fire

The system has been implemented through various pahses

- Phases: 1999-2002: development of the system from **adaptation of the Canadian FWI; operationalization of the system and, application**.
- Capacity building
- Product dissemination
- Involvement of other institutions through capacity building on
    - Initial spread index, fore weather index
    - Promotion of product users
    - Development collaboration with information providers
    - NB population still use traditional evaluation to determine a suited burning period.

FDRS in Malaysia: Ahmad Zaki Mohamed Saad

The presentation emphasizes the importance of Forest Fire and haze episodes. The impacts of fire, apart from direct ecological aspects are:

- affect tourism
- health of population
- transport
- sport and educational activities

It is therefore very important to prevent forest fire through FDRS mainly also to protect the life and property, serve as a FD monitoring and preparedness for decision to policy makers.

The model working since 2003 and maintain by the Met department. Some problems have been encountered such. For instance an Index based on weather alone can lead to high risk in flooded areas as it happened in Malysia.

FDRS in New Zealand, Jim Salinger

The author noted the increase of arson (criminal fires) in N-Z, and showed that most fires in the country are human fires and become a big issue in this country.

Weather and climate increase fire risk and significant fires often occur under hot and dry wind in Oct-April.
N-Z adopted the Canadian FWI.

FDRS in Peru, Maria Isabel Manta Nolasco

Fires in Peru are 100% of fire are human caused, and occur during the dry season July-October. They also use the FWI of Canada. Moreover, Peru had developed a good met network and a real time update of national met data.

In an operational view point, forest fire risk index is developed and calibrated at national level after:

- training of personal
- elaboration of a procedure guide of local populations
- investigate fire behaviour
- Early warning
- Define burning calendar
- Implement programs of prescribe fire
- To collaborates with fire control programs (Univ, met et hydro department, civil defence, strategic partners)
- Promoting South American met early warning system

Technical presentations

Ivan Csiszar from Maryland University; Anatoly Sukhinin, Douglas J. McRae, Eugene Ponomarev
Presented a study implemented in Russia
They use of AVHRR 3 channels 1, 2 for surface albedo and channel 5 for surface temperature proxy. The images were corrected for FDR based on precipitation occurrence. In cases where cloud is a problem, they used the microwave NOAA TOVS instrument data. The products were integrated in a GIS to overlay fuel layers, temperature pressures and cloudiness. Data used are: forest fuel map, met data, satellite data, storm data and biomass productivity. The model was good enough for subsequent decision making

Karen, Chris de Bruno Austin, South Africa
They used the Mc Arthur grassland model developed in the 1970s combined with weather stations data assuming that all Fine Fuel of grass cover types are cured at may.
The aim of this system was to help initial attack responses, fire suppression, readiness alert, prescribe burning activities, fire awareness program, maintenance and damage prevention, data logging and retrieval methods for average fire seasons with 5 months and 153 days, back ups.

Data handing was based on retrieval of information out from field to central terminal. The use of mobile cell phone with a service provider helped transfer data such as wind speed, direction barometric pressure, rainfall, at 10 and 14 h. With this system they are able to to characterize the actual and 5 days forecast (sent via mobile fax a FDIndex using software called WINWIS: Window Weather Information System).

Karen and Philip Frost: CSIR Meraka Institute, South Africa
Developed an advanced fire information system for a:
- detection of active fires in near real time
- assessment of damage after burining
- and prediction in FDI

They used AFIS as a research tool for multi satellite sensors analysis. The main user of the outcomes in an electricity company called ESKOM. This company is interested in Flash over flash over probability and daily FDI product, integrating weather data in AFIS (100). The information is disseminated through EUMESAT system. Next step is to use the coming MODIS 500 burned areas products.

Antonio Mestre, Spain
New FDR in development: fire increasing in Spain, but the fight system is improved and the annual increment has decreased. FDRS, is based on FWI of CFS.

Matt Jolly, USA
US National Fire Danger rating system: past present and future
- Use of FDRS for making decision
- Future directions of NFDRS of US
- 1972-1978, first national System, modified I, 1988
- Based on 2200 remote automate weather stations (RAWS) national wide
- All manager have control on their stations: bottom up approach
- Each station represent the area: indices is calculate for each FD area
- Interpolate point values and interpolate them spatially

The system use an invert distance interpolator for observed fire danger class interpolation.
Use of fire danger for:
- fire danger signs
- public closures and burning restrictions
- logging operations restrictions
- dispatch and staffing levels
- prepositioning resources
- situational awareness for fire fighters safety
- Wildland fire use decisions

In addition, they compare historical fire danger to fire occurrence, based on climatologically breakpoints (threshold values). Perform logistic regressions between fire occurrence and weather index. That is the base for breakpoints set up. Knowing how to move from points to grid base location would be necessary. Operational gridded products will be based on integration of national digital climate information with FDI. They need therefore to:
- revisit the current NFDRS
- develop radiation driven dead fuel moisture
- set a new live fuel moisture model
- forecast based on gridded surface weather observation.

Nick Nimchick: Assessing FD in Alberta. Application of the Canadian FDRS.

FDR help to advent the pre suppression and fire operations and management and requires technologies in data collection. Fire growth modelling required indirect method on factors most influential of fuel moisture content. Direct methods being expensive and time consuming. The set up included a set lookout towers network, the use of Global Start telemeter (the system to track criminals), for information transfer and the use of low cost low technology for data transmission.

Tim Linham: Global Early Warning System for Wildland Fire
FDR and weather are the backbone of Wildland fire early warning and prevention. FDR is crucial for:

- detection
- resource mobilization
- international coordination,
- mobilization of suppression resources.

Large part of the world does not have any kind of FDRS. But there are few possibilities acting at global scale. Global fire Monitoring Centre (Johan Goldammer) is one of those and act as a hub for regional data, and take information from Actives fires detection and a back flow is done via web page.

Francis Fujioka, USDA, California
Statistical modelling of fire risk
WFDSS: Wildland Fire decisions Support System: a prototype

- Models components: fire behaviours, weather, spread probabilities
- Modelling fire probabilities

Needs:

- Minimize cost of fire fighting (.3 b$ 2000-04)
- Use advances in weather and fire modelling and geospatial analysis including RS.
- FSPro: fire danger maps for incident, probability of a pixel being burned
- Inputs: weather (air temp, RH, wind direction, wind speed)

Summary of Session 2. Michel Brady, and M. Field

Commonalities of systems

- few technologies hurdles, much human resource capital
- need for standardization of fire danger RS
- common emphasis on simplicity
- spatial FD displays predominate
- Newer systems backed up by validation and local adapatation
- Broad range of expertise: fire and forest, meteorological data, RS/GIS
- Distinction between fire detection and fire potential

Differences in systems

- State of development of systems
- Broad range of application
- Development of new systems, Vs adoption of existing system
- Difference in weather data management and procedures
- Differences in level of communication between FDRS operations and users

Common problems:

- need of on going calibration and validation
- incorporate local knowledge of quickly change synoptic conditions in the context of national system
- find balance between the available of automated fire danger information and the need for expert assessment.
- Making use of new forecast products
- How to use RS data for met inputs
- Consistency in various scale systems
- Reliance on expérimental satellites (eg. MODIS)

Comments:

- The scale issue : information at decision making
- Data needs: how to get required information
- Dissemination of FDRS
- Specific goals of the system
- Equipment and techniques
- Capacity building

Breakouts sessions: BG1 (WARN Presentation in this session)

1. Remote Sensing vs surface networks
    a. Methods of combining RS data and surface network data: hybrid system
    b. Hybrids may have applications operationally, necessary to fill in gaps
    c. RS used for biomass observations
    d. Quality and accuracy of RS data
2. Manual versus automatic observations
    a. Manual weather observations
        i. Confidence in reports? Great variability
        ii. Training of operators
        iii. Expensive
        iv. More suited for certain data
    b. Automatic observations
        i. Confidence in technologies, regular calibration required
        ii. Can take more frequent samples (minutes) valuable for data archiving
3. Representative stations
    a. areas of coverage for surface stations , network density
        i. denser network required; topology to determine density
        ii. keep the system simple
        iii. know the accuracy requirements of the application
4. Sharing data between networks
    a. Metadata documentation
    b. More efficient use of data for different disciplines
    c. Data standardized across networks
        i. Feasibility, difference of sampling techniques/instrument
        ii. Disparity of networks/sophistication; speed of data handling
        iii. Variation of standards depending to regions
5. Changing climate, affect:
    a. Requirement in instrument used
    b. Species duration

   c. Length of fire season, increase fire intensity
6. Software
   a. How to ensure knowledge and availability

BG II

Topics covered

- maps and analysis
  - are standard for FDR, using simple interpolation schemes (can be improved)
    - recommendation: calculate FDR from interpolated weather
    - move towards physical modelling and assimilation using mesoscale models
    - assimilation should include non weather variables of interest to fire managers
- numerical weather prediction (nwp)
  - nwp are readily available and are now being incorporated into fire FDRS
    - recommendation: explore the use of ensemble products (weather models outputs can be in play in FDRS)
    - recognize the acknowledge of nwp errors
- Vertical structure
  - Impacts the upper atmosphere on fire behaviour has been well established but poorly applied to FDRS
    - Historical analyses can be done now to provide context
    - Can be introduced into variability
    - Direct or indirect incorporation
- Seasonal prediction
  - Weather forecast can be produced for next several months
    - Concerns: who uses it, at what scale, impacts of decisions based on predictions
- Uncertainty
  - Errors biases and variability
    - Acknowledge errors
    - Be aware of transition points

BG III

- What additional variables are more critical
  - DEM
    - USGS DTM, SRTM, terrain will complement faire behaviour
  - FMC, live fuel moisture
    - MODIS CWC soon available (measure EWT- water per area but not FMC-water per dry mass)
    - Ground validation data of FMC
    - Need to establish critical thresholds: grass curing, moisture, extension
  - Fuel type maps
    - Critical factor both for ignition and propagation, but information not available
    - Previously based on land cover , vegetation maps, risky
    - Various levels or detail are needed (Fire danger estimation, Fire behaviours modelling, fire effects assessment)

        - Update fuel types maps periodically
    - Human factors
        - Explain spatial variability of fire occurrence in most countries
        - They are related to ignition potential and vulnerability of fires and fire impacts
        - Some factors can be modelled with GIS: distance to road; urban wildland interfaces, power lines camp ground, land use interfaces
        - Temporal trends were observed as well
    - Fire history
        - Hot spots from MODIS, ATSR, AVHRR
        - Burned scars: MODIS, SPOT, Landsat, fire perimeter
        - Fire ignition points
- Methods for integration
- Methods for validation
    - Need of independent sample
    - Differentiate between risk and actual occurrence
    - Use of satellite data (hotspots, burned areas)
- Specific actions:
    - Implementation DEM in FDR
    - Common data base of FMC ground measurements/RS estimations
    - Generation of fuel type maps and fuel models
    - Characterization of human factors
    - Integrate historical fire occurrence
    - Common validation protocols.

BG IV Data Management, issues and challenges

- data sharing (institutional constraints, traditional thinking)
- changing technologies (software and data acquisition)
- availability of institution expertise
- available resources (long term maintenance, skill)
    - labour intensive, requires human resources
- metadata

What are the key components?

- acquisition >sharing, accessibility, agreements in place>data entry, storage, archiving>quality control>security

Recommendations

- make sure use of existence resources
- use international standards
- determine expertise level to select software
- base system on current needs
- data collection standards
- standard data model
- contingency plan (changing technology, lapsing data sharing agreements)
- share data
- build in redundancy as required
- data integration into other systems
- well documented metadata

NB. Standardization (have the same approach) different to harmonization (set consistent data base from various sources)

BG V
Goal for FDRS vary between countries, agencies
Validation approach depends on application
Different time and space scales for FDRS implementation
What are the most significant problems?

- Lack of historical data and fire records-proxy available?
    - Remote sensing data, when validated can be use to approach rainfall data needs for weather index development
- How to cope with vegetation/terrain variation
    - Fuel typing is a long process so is a long term goal
    - Political climate may hinder goals
    - Explore development of systems based on vegetation in climate zones
    - Catalogue main fuel types and model
    - Internet gateway to support developing countries with programs, technical support etc.
- Select aspects of the system that are most pertinent first/main issues
- Understand conditions under when fires occur
- In historical reconstruction, consider anthropogenic movements/trends
- Significant calibration sometimes needed but simplicity needs to be considered
    - Some regions may experience fire danger values outside normal range found in country that developed the prototype
    - Fields observations important
    - Workshop to teach technical implementation of FDRS
- Need to understand fuel moisture dynamics and fire behaviour in various materials
- Operational application versus scientific research
- Resources required versus resources available in selection of method

Validation approach

- experimental fires
- statistical analysis of fire records/MODIS detects/ visibility data
- case studies
- operational experience

Sivakumar, WMO (Concluding remarks)
WMO was created 1950, successor of International Met Org (IMO, 1873). Sivakumar stressed important document available on line.

- Special environmental report 11 (copy to be taken)
    - after Stockholm 1972, research on forest meteorology
- CAgM report 10 (wildland fires to)
- Chap 8 Application of met to forestry and non forest trees, (on the web page)
    - tree reponse to met elements
- Report 131,WMO n° 948
- Climate and land degradation (Sivakumar edition)

Proposition to publish a book from the workshop (book chapters invitation, about 20 pages)