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DEPARTMENT OF THE ENVIRONMENT – CANADA

Technical Memoranda

CALCULATION OF FIRE DANGER INDICES BY COMPUTER

by

S. NIKLEVA and L. PARENT

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ENVIRONMENT CANADA - ATMOSPHERIC ENVIRONMENT SERVICE
4905 Dufferin Street
Downsview, Ontario

CALCULATION OF FIRE DANGER INDICES BY COMPUTER

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ABSTRACT

There will be an increasing future demand for fire danger indices to be included in fire weather forecasts. The use of a commercial time-sharing computer system to meet this requirement is described.

CALCUL PAR ORDINATEUR DES INDICES DE RISQUES D'INCENDIE

par

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L. E. Parent

RÉSUMÉ

La demande d'indices de risque d'incendie qui seront donnés dans les prévisions des risques d'incendie en fonction du temps sera de plus en plus forte. Les auteurs décrivent l'utilisation sur une base commerciale d'un système d'ordinateur fonctionnant en temps partagé pour répondre à ce besoin.

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(Manuscript received February 18, 1971, revised March 11, 1971)

Introduction

Industry and government organizations responsible for protecting the forest from wild fires have required an objective method for determining the probability of occurrence, the rate of spread, and the difficulty of control of forest fires. In the past many different systems for rating fire danger were used in British Columbia and elsewhere in Canada. Although the fuel moisture was a basic ingredient in nearly all systems, there were wide variations in the way this quantity was estimated and in the complexity of the assumed relations between fuel moisture and weather elements. Under identical fuel and weather conditions many of the systems did not rate the fire danger the same making it difficult to attain a uniform approach to fire control problems.

The Canadian Forest Service has accepted the responsibility for developing methods of measuring forest fire danger. The first fire danger tables were issued for Ontario in 1933; however, fire danger tables were not completed for the province of British Columbia until 1961.

Since then, changing forest management practices led to a need for greater precision in the measurement of fire danger, and the Canadian Forest Service developed a new improved fire danger rating system. Provisional tables for determining the new indices were published in 1969.

As an experiment, it was agreed that the Vancouver Weather Office should undertake the calculation of the new indices for the B.C. Forest Service and include these with the fire weather forecasts provided to their protection division. This required daily calculations, by the Vancouver Weather Office, of the current day indices for 70 stations, and of the forecast indices for 33 stations.

Although hand calculation of the indices was a straight forward procedure, it involved using 10 tables for a single station calculation. As indices for many stations were required, the calculating time was considerable.

This was particularly significant to the Vancouver Weather Office program of calculating the indices centrally for later distribution to field offices. As local forestry communication links were often fairly

slow, and as the indices were based on meteorological observations taken at 1 p. m. local daylight saving time, a computer capability was essential for reducing the calculating time sufficiently so that the computed indices could be distributed in the same working day to the field personnel.

To meet Vancouver Weather Office requirements, a computer program for calculating the various components of the fire weather index was developed and used operationally on a commercial time-sharing computer system during the 1969 and 1970 fire seasons.

Since the new fire danger index has application to the entire nation, the above program could benefit any office required to prepare fire danger indices for many locations.

Additional advantages of computer calculation of the indices were: human error was reduced; all the component parameters were readily presented in tabular form for convenient record keeping; it was a more economical method than the use of tables by a technician.

Canadian Fire Weather Index

For those readers unfamiliar with the Canadian Fire Weather Index a brief description is included below. Further details may be found in references 1-3.

It is obvious that a fire danger rating system must measure the moisture content of the forest fuels. In the Canadian Fire Weather Index the moisture content of the entire forest fuel complex is simulated by three code numbers. The fine fuel moisture code (FFMC) represents the moisture content of the fine fuels such as pine needles. These are the first fuels to dry out. The duff moisture code (DMC) depicts the moisture content of the duff layer, or of small sticks. The third moisture parameter is the drought code (DC) which represents the moisture in very dense fuels or in deep organic layers. The above three components and the meteorological observations necessary for their calculation are illustrated schematically by the three blocks at the top of Fig. 1.

The DMC and DC are integrated to form the adjusted duff moisture code (ADMC) which is a useful parameter relating to the long term drought.

The initial spread index (ISI) is a numerical rating of the relative spread of fire, and, therefore, strongly dependent on wind speed.

The fire weather index (FWI) combines the rate of fire spread (ISI) and the amount of fuel available for burning (ADMC). As a consequence, it measures the potential fire intensity. All the indices refer to a standard fuel type.

The main parameters in the new fire danger rating system are the FWI and ADMC, and in B.C. the Provincial Forest Service is incorporating these indices into its fire protection regulations. Although these two indices meet most of the needs of the protection agencies, a study of the changes occurring in the component indices often yields useful information. The computer program, therefore, outputs all the parameters shown in Figure 1. The number of parameters distributed to the protection agencies would in general depend on their particular requirements.

Computer Program for Daily Calculation of Fire Weather Index

The flow chart for the computer program used on the IBM Time-Sharing Computer System is illustrated in Figure 2. A similar program had been previously developed for use on the Canadian General Electric Time-Sharing Computer System. Further technical information and copies of the program may be obtained from the authors.

The Canadian Forest Service has recently published FORTRAN subroutines for the various indices (Simard 3). These subroutines have been incorporated into the above-mentioned IBM computer program making it compatible with the fire danger tables published by the Canadian Forest Service (Anon. 1).

Further Developments

The Vancouver Weather Office has been developing a more comprehensive program to assemble the various sections of the fire weather forecast into the proper format, and to prepare a paper tape of the complete forecast suitable for the immediate transmission on the MSC automated teletype system. The output tape could include specific fire weather parameters obtained by computer methods from information routinely available from the Weather Office. Information on this combined program will be published later this year and may be of use to Weather Offices with a well developed fire weather program.

Summary and Conclusions

Increasing national use of the Fire Weather Index, coupled with expanding meteorological services for specialized users, will result in a greater future demand by fire control agencies for these indices to be included in the fire weather forecasts.

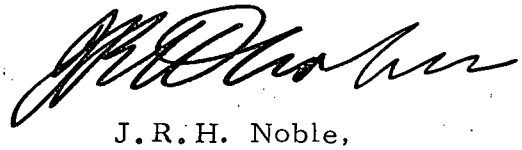
During the 1969 and 1970 fire seasons, the Fire Weather Index was calculated by a commercial time-sharing computer system for operational use at the WOVR.

This procedure not only provided a rapid means of calculation, which was an essential requirement for meeting operational deadlines, but also it presented error free results in convenient tabular form. Furthermore, calculation by computer was found to be a more cost effective method than calculation by technicians.

Acknowledgements

The authors would like to thank Mr. Turner, Canadian Forestry Service, Forest Research Laboratory, Victoria, B.C., for his assistance in providing the mathematical functions corresponding to the forestry tables.

APPROVED



J.R.H. Noble,
Assistant Deputy Minister,
Atmospheric Environment Service.

Figure 1.

Block Diagram of Forest Fire Weather Index, (Anon., 1)

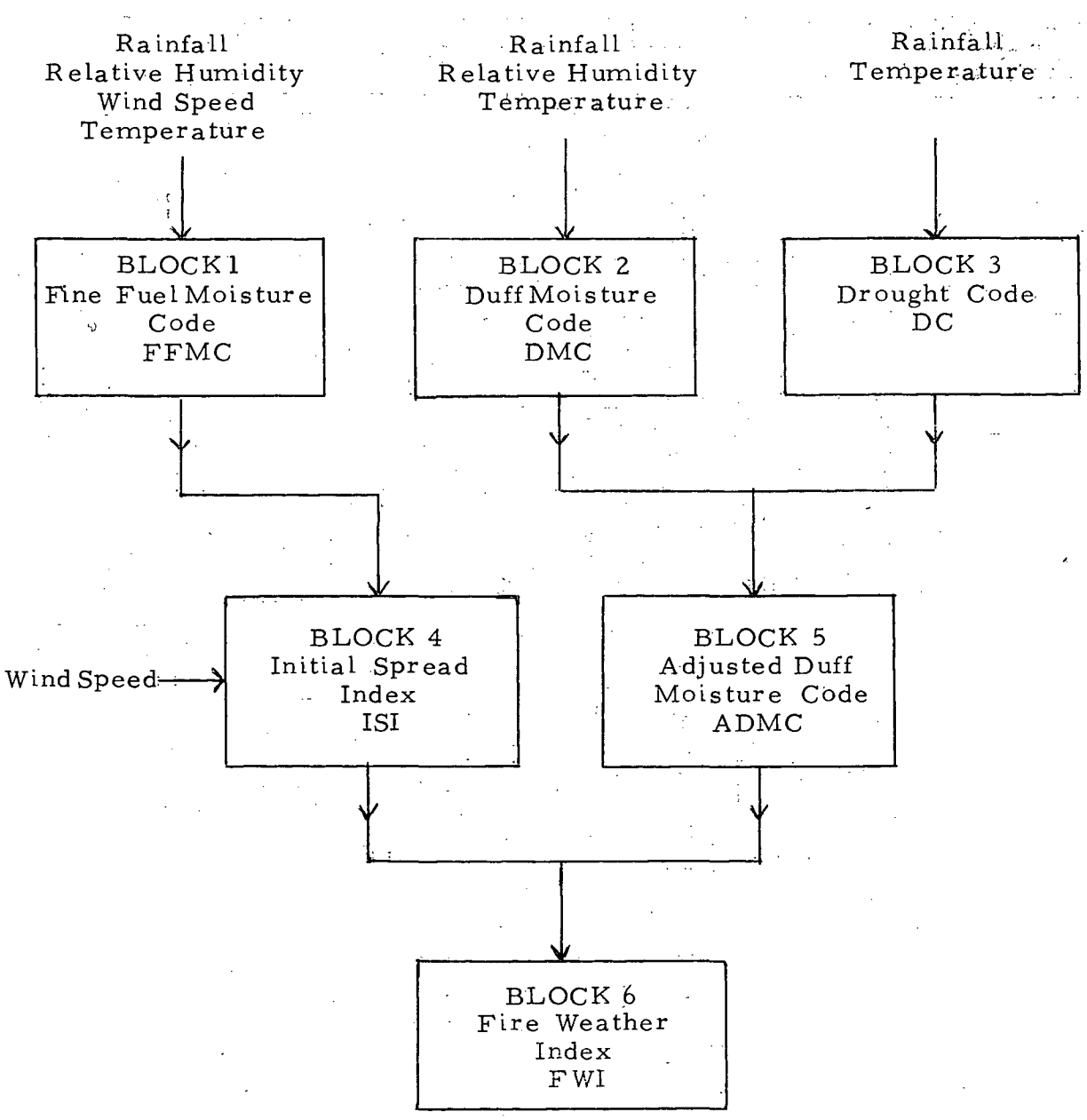
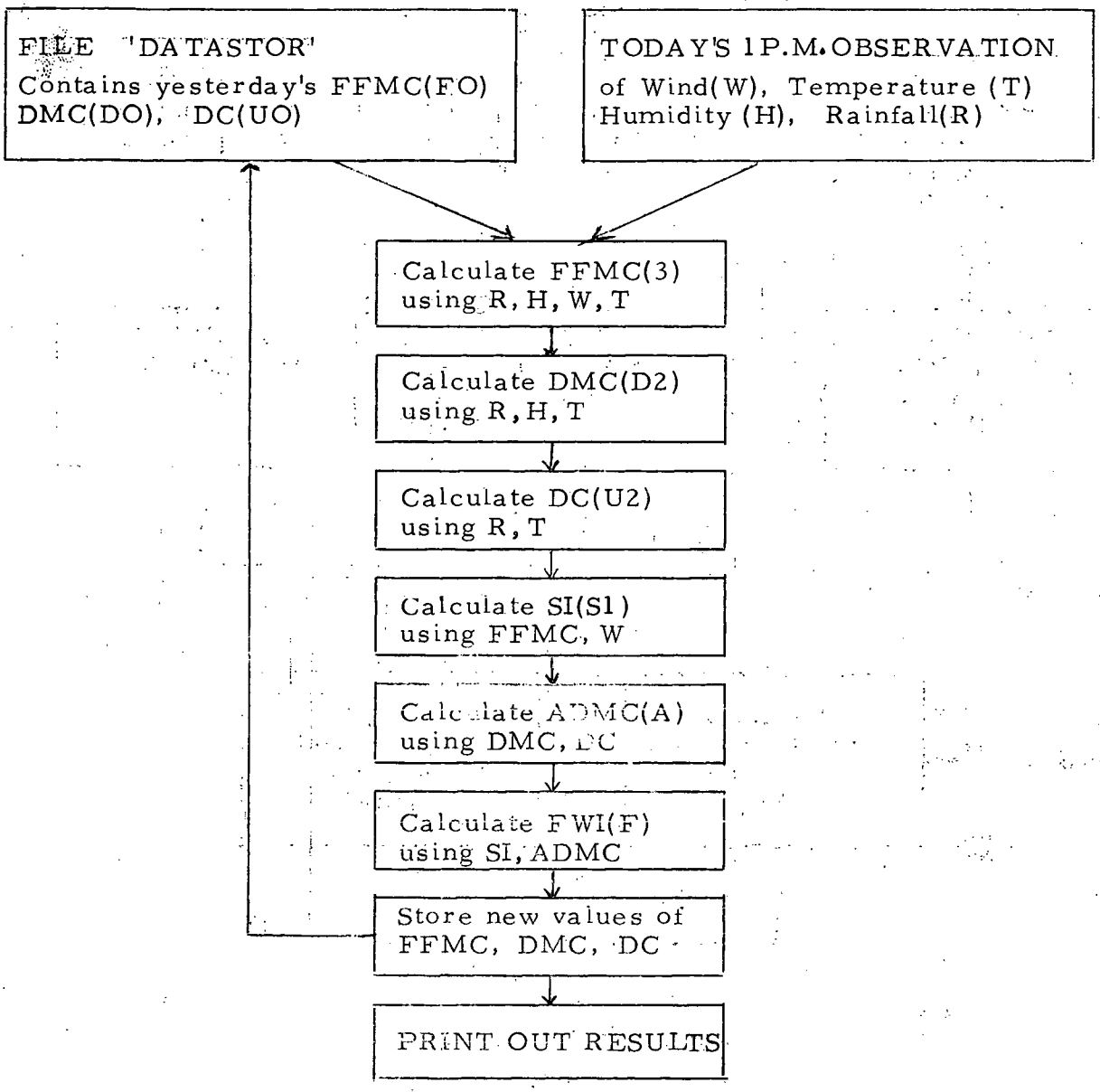


Figure 2.

FLOW CHART



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