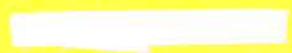


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PDP 8L VERSION OF SIMARD'S FIRE WEATHER INDEX PROGRAM

by
R.L. Engisch and J.D. Walker

**PETAWAWA FOREST EXPERIMENT STATION
CHALK RIVER, ONTARIO
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**CANADIAN FORESTRY SERVICE
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Fire Weather Index Program

by

R.L. Engisch^{1/} and J.D. Walker^{2/}

In February, 1970, A.J. Simard^{3/} of the Forest Fire Research Institute published a computer program to calculate the Forest Fire Weather Index for a number of stations and years at a time. It was designed to process weather data from the various fire danger research sites operated throughout Canada during the 1950's and 1960's. It is a complex program and requires a computer with large storage capacity for its operation.

The program described in this report is a greatly simplified version of Simard's work and was written for use on the Digital PDP 8L at the Petawawa Forest Experiment Station. It includes only the mathematical functions necessary to compute the codes and indices for one station, one year at a time. It does not include such features as the optional starting routine, the checks for unrealistic data, or checks and routines for dealing with missing data.

The program was written with the calculation of the various codes incorporated within two large "DO" - loops rather than using sub-routines. This was possible because, as mentioned, only one year's fire weather data from one station are processed in a run and it is assumed that the data are valid and complete. The mathematical steps of the program are self-evident and will not be discussed here; in any event they can be referenced in other publications. The main advantage of the program described here is that the FWI and its components can be calculated

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3/

Simard, A.J. 1970. Computer Program to Calculate the Canadian Forest Fire Weather Index. Canadian Forestry Service. Forest Fire Research Institute. Internal Report FF-12.

using a small, inexpensive and usually readily available computer. Also, if any modifications to the FWI equations are contemplated, they can easily be tried and tested with this simplified program. If a researcher wants only one particular year's values calculated for a specific project, the use of this version on a small computer may facilitate his handling of the problem.

The program includes no limits on the input data or intermediate values other than those necessary to prevent mathematical anomalies. Also, all moisture codes are carried from day to day in precise floating-point format, as are all intermediate values leading to the daily FWI. Only when printed out are the codes and indices rounded off. One or two decimal places are retained for better accuracy in comparison work.

The computer at PFES is a Digital Equipment Corporation PDP 8L which uses paper tape input. The computer has 8k storage of which 4k are library programs and the other 4k for program operation. This program required about 3.5k to operate. Output control of the computer is through an ASR 33 teletype with a low speed paper tape reader and punch. The teletype prints output at a rate of 10 characters per second. Input control is via a high speed paper tape reader at a maximum 300 characters per second. Run time, including output, for one year's data is approximately 30 minutes. The program was written in DEC-oriented Fortran II language.

The following list includes all the significant variables found in this program:

ADMC	- Adjusted Duff Moisture Code
DC	- Drought Code
DMC	- Duff Moisture Code
DOT	- Yesterday's DC
FFM	- Fine Fuel Moisture Code
FO	- Yesterday's FFMC
FWI	- Fire Weather Index
H	- Relative Humidity (percent x 100)
PO	- Yesterday's DMC
R	- Rain fall (inches)
SI	- Initial Spread Index
T	- Temperature (°F)

W - Wind speed (m.p.h.)

The program requires two data loading tapes. The first tape contains the information required for the three dimension statements and the initial starting values. The three dimension statements include the number of days in each month (LMON) and, the day-length factor (EL) and seasonal factor (FL) for each month. The initial values FO, PO, and DOT which are read in, are predetermined. M and N represent the first and last month for which data has been collected. LMON, M, and N must be read in to coincide with each year's field data. For example, if the data start on April 25 and run to October 31, then LMON for the fourth month would be 6 and M and N would be 4 and 10 respectively. The values for EL and FL are the same as those used in Simard's program and are shown in the dimension tape sample. The printout for the first month always starts at day 1 (see sample printout). The second tape read in is the daily noon weather and includes wind speed, temperature, relative humidity, and rainfall.

The program prints column headings and numerical output in the following order; month and day (J, I), wind speed (W), temperature (T), relative humidity (H), rain fall (R), fine fuel moisture code (FFM), duff moisture code (DMC), drought code (DG), initial spread index (SI), adjusted duff moisture code (ADMC), and fire weather index (FWI).


```

C   FINE FUEL MOISTURE CODE
    IF(R-0.02) 5, 5, 10
5   R=0.0
    FR=FO
    GO TO 150
10  RA=R
    IF(RA-0.055) 6, 6, 11
11  IF(RA-0.145) 9, 9, 12
6   F=-56.0-(55.6*ALOG(RA+0.04))
    GO TO 13
9   F=-1.0-(18.2*ALOG(RA-0.04))
    GO TO 13
12  F=14.0-(8.25*ALOG(RA-0.075))
13  C=8.73*EXP(-0.1117*FO)
    FR=(FO/100.)*F+(1.0-C)
    IF(FR) 15, 150, 150
15  FR=0.0
150 WMO=101.-FR
    ED=0.942*(H**0.679)+(11.*EXP((H-100.)/10.))
    IF(WMO-ED) 26, 27, 28
26  EW=0.597*(H**0.768)+(14.0*EXP((H-100.)/8.))
    IF(WMO-EW) 29, 27, 27
27  WM=WMO
    GO TO 30
28  X=0.424*(1.-(H/100.)**1.7)+(0.088*(W**0.5))*(1.-(H/100.)**8)
    WM=ED+(WMO-ED)/10.**X
    GO TO 30

```

```
29   WM=EW-(EW-WMO)/1.9953
30   DF=0.663*T+0.448*FR-0.0064*T*FR-46.6
      FFM=101.-WM+DF
      IF(FFM-101.) 31, 31, 32
31   IF(FFM) 33, 34, 34
32   FFM=101.
      GO TO 34
33   FFM=0.0
C     DUFF MOISTURE CODE
34   IF(T-30.) 40, 41, 41
40   T=30.
41   RK=1.052*(T-30.)*(100.-H)*(EL(J)*0.0001)
      IF(RK) 42, 43, 43
42   RK=0.0
43   IF(R-0.06) 44, 45, 45
44   PR=P0
      GO TO 250
45   RA=R
      RW=0.92*RA-0.05
      WMI=20.0+280./EXP(0.023*P0)
      IF(P0-33.) 50, 50, 51
51   IF(P0-65.) 52, 52, 53
50   B=100./(0.5+0.3*P0)
      GO TO 55
52   B=14.-1.3*ALOG(P0)
      GO TO 55
53   B=6.2*ALOG(P0)-17.2
```

```

55   WMR=WMI+(1000.*RW)/(1.92+R*RW)
      PR=43.43*(5.6348-ALOG(WMR-20.))
250  IF(PR) 60, 61, 61
60   PR=0.0
61   DMC=PR+RK
      IF(DMC) 62, 63, 63
62   DMC=0.0
C    DROUGHT CODE
63   IF(T-27.) 64, 65, 65
64   T=27.
65   PE=(0.2*(T-27.)+FL(J))/2.
      IF(R-0.07) 300, 81, 81
81   RA=R
      RW=0.83*RA-0.05
      SMI=800.*EXP(-DOT/400.)
      DR=DOT-400.*ALOG(1.+((100.*RW)/SMI))
      IF(DR) 82,82, 83
82   DR=0.0
83   DC=DR+PE
      GO TO 350
300  DR=DOT
      GO TO 83
350  IF(DC) 84, 85, 85
84   DC=0.0
C    INITIAL SPREAD INDEX, ADJUSTED DUFF MOISTURE CODE, FIRE WEATHER
C    INDEX
85   FM=101.-FFM

```

```

SF=19.115*EXP(-0.1386*FM)*(1.+FM**4.65/7950000.)
SI=SF*EXP(0.3811*W)
IF(SI) 92, 93, 93
92  SI=0.0
93  ADMC=(0.8*DC*DMC)/(DMC+0.4*DC)
    IF(ADMC-DMC) 94, 95, 95
94  P=(DMC-ADMC)/DMC
    CC=0.92+(0.0114*DMC)**1.7
    ADMC=DMC-(CC*P)
95  IF(ADMC) 96, 97, 97
96  ADMC=0.0
97  BB=0.1*SI*(0.626*ADMC**0.809+2.)
    IF(BB-1.0) 98, 98, 99
99  SL=2.72*(0.434*ALOG(BB))**0.647
    FWI=EXP(SL)
    GO TO 400
98  FWI=BB
400 IF(FWI) 76, 77, 77
76  FWI=0.0
77  WRITE(1,1001) J,I,W,T,H,R,FFM,DMC,DC,SI,ADMC,FWI
    FO=FFM
    PO=DMC
    DOT=DC
301 CONTINUE
25  CONTINUE
1001 FORMAT(2I3,F6.0,F5.0,F6.0,F6.2,F8.2,F7.1,F7.1,F7.2,F7.1,F6.1)
    STOP
    END

```

DATE	WIND	TEMP	REL. HUM.	RAIN	F. F. MOIST.	DUFF MOIST.	DROU. CODE	SPREAD INDEX	ADJ. D. MC.	FIRE INDEX
4 1	17.	49.	42.	.00	85.53	7.5	17.7	9.27	7.5	8.3
4 2	9.	31.	33.	.00	84.90	7.6	18.6	4.48	7.6	4.2
4 3	8.	38.	17.	.00	88.38	8.5	20.2	6.47	8.4	6.4
4 4	14.	32.	54.	.00	84.39	8.6	21.2	6.31	8.6	6.3
4 5	6.	53.	33.	.14	68.55	7.5	20.8	.81	7.9	.4
4 6	4.	45.	78.	.07	53.00	6.8	22.7	.32	7.8	.2

DATE	WIND	TEMP	REL. HUM.	RAIN	F. F. MOIST.	DUFF MOIST.	DROU. CODE	SPREAD INDEX	ADJ. D. MC.	FIRE INDEX
5 1	15.	45.	38.	.00	73.91	8.2	26.0	2.38	9.2	2.1
5 2	7.	42.	26.	.00	82.38	9.5	29.0	2.81	10.4	2.9
5 3	4.	32.	90.	.05	59.44	9.5	31.0	.44	10.8	.3
5 4	16.	48.	29.	.07	72.27	10.2	34.2	2.30	11.7	2.4
5 5	12.	58.	41.	.00	82.72	12.6	38.8	4.39	13.9	5.7
5 6	5.	35.	90.	.08	45.81	10.7	40.2	.23	12.9	.2
5 7	8.	36.	29.	.12	56.89	8.1	39.8	.53	10.7	.3
5 8	8.	38.	33.	.00	72.74	8.9	42.4	1.24	11.7	.8
5 9	13.	36.	38.	.00	79.19	9.4	44.8	3.23	12.3	3.9
5 10	17.	42.	30.	.00	84.66	10.6	47.8	8.32	13.7	10.1
5 11	9.	48.	29.	.00	87.23	12.5	51.4	6.03	15.6	8.2
5 12	6.	53.	29.	.00	88.59	14.9	55.5	5.66	17.8	8.3
5 13	10.	60.	21.	.00	91.35	18.4	60.3	11.34	20.9	15.8
5 14	5.	66.	18.	.00	93.05	22.7	65.7	9.54	24.4	14.9
5 15	3.	54.	41.	.00	90.58	24.8	69.9	5.79	26.3	10.5
5 16	4.	55.	70.	.06	71.33	25.1	74.2	.82	27.2	.9
5 17	4.	60.	63.	.22	54.82	16.9	71.1	.35	21.2	.3
5 18	8.	60.	68.	.00	70.14	18.3	75.9	1.05	22.8	1.2
5 19	7.	70.	34.	.50	71.18	12.3	60.2	1.03	16.3	.8
5 20	7.	63.	46.	.17	66.37	10.2	60.1	.78	14.4	.6
5 21	10.	66.	39.	.00	82.87	13.4	65.5	3.80	17.8	5.7
5 22	4.	71.	30.	.00	88.99	17.6	71.4	5.07	21.8	8.4
5 23	8.	77.	26.	.00	92.05	22.7	77.9	10.62	26.3	16.8
5 24	11.	87.	34.	.00	93.11	28.2	85.4	15.66	30.9	24.1
5 25	8.	74.	26.	.08	84.60	29.9	90.6	3.98	32.7	8.6
5 26	12.	74.	31.	.00	90.16	34.3	96.8	11.35	36.4	20.8
5 27	7.	72.	43.	.10	77.55	32.0	100.7	1.69	35.6	4.0
5 28	7.	58.	37.	.04	80.78	34.6	105.3	2.35	38.0	5.8
5 29	9.	49.	61.	.00	80.70	35.6	109.0	2.74	39.2	6.9
5 30	9.	52.	49.	.09	68.71	32.3	111.4	1.04	37.5	2.3
5 31	6.	52.	60.	.03	73.38	33.6	115.4	1.10	38.9	2.6

DATA ON DIMENSION TAPE

<u>LMON</u>	<u>EL</u>	<u>FL</u>
31	6.5	-1.6
28	7.5	-1.6
31	9.0	-1.6
30	12.8	1.0
31	13.9	3.0
30	13.9	5.3
31	12.4	6.4
31	10.9	4.9
30	9.4	2.0
31	8.0	0.0
30	7.0	-1.6
31	6.0	-1.6

INITIAL VALUES

FO - 85.0

PO - 6.0

DOT - 15.0

M (FIRST MONTH)

4

N (LAST MONTH)

10