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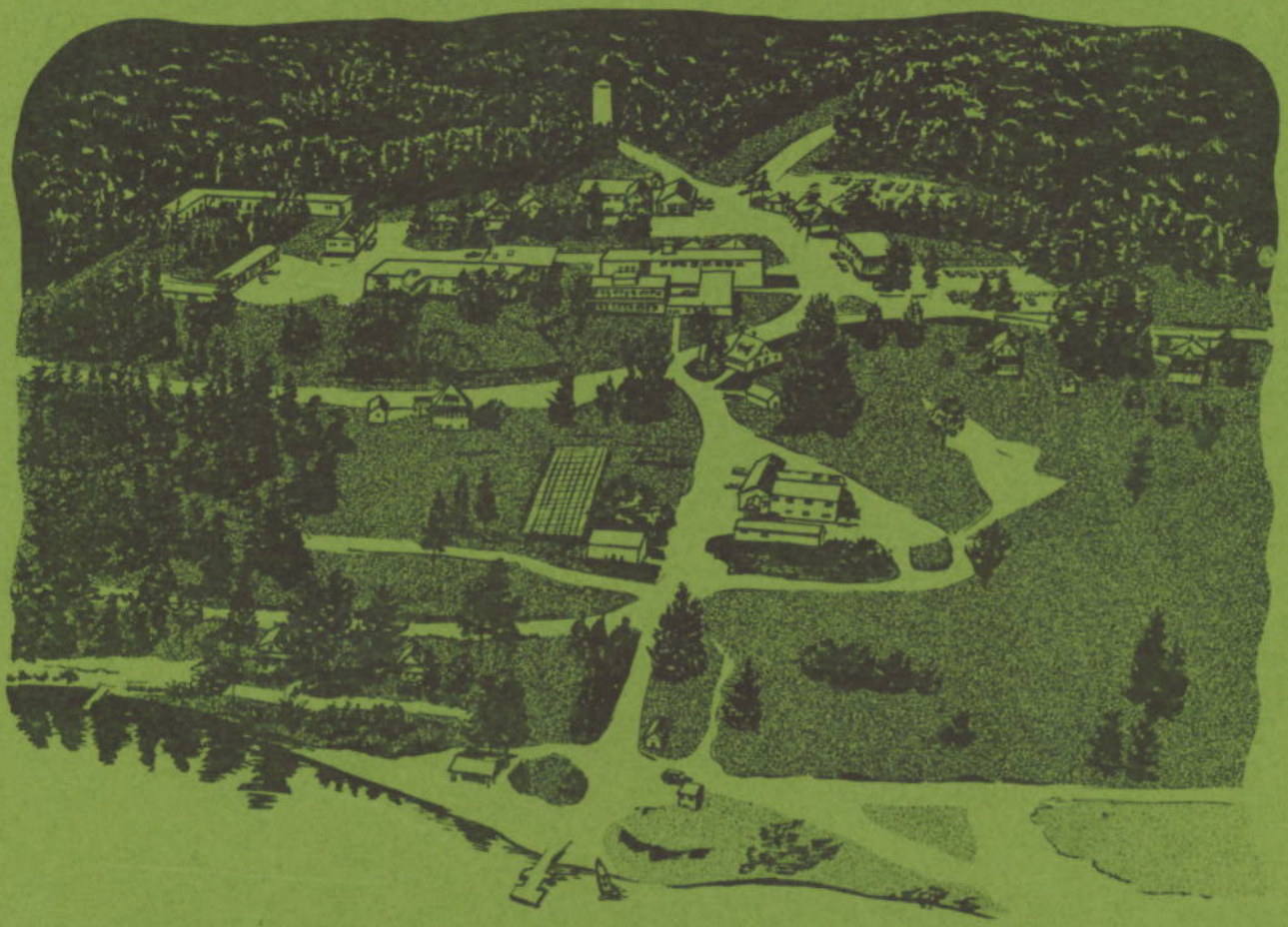
A PDP-8L PROGRAM FOR CALCULATING THE FIRE WEATHER INDEX.

by W.A. Kean

(A Revision and updating of
Internal Report PS-23, 1971,
R.L. Engisch and J.D. Walker)



PETAWAWA FOREST EXPERIMENT STATION
CHALK RIVER, ONTARIO
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A PDP-8L Program for calculating the Fire Weather Index

by

W.A. Kean[1/]

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In February, 1970, A.J. Simard[3/] of the Forest Fire Research Institute published a computer program to calculate the Forest Fire Weather Index[4/] 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.

In 1971, R.L. Engisch[1/] and J.D. Walker[2/] published Internal Report PS-23 which greatly simplified Simard's work. Since then, mathematical and output changes have been made to the program and for this reason a revision of the publication was desirable.

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

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1/ Forest Research Technician, Canadian Forestry Service, Petawawa Forest Experiment Station, Chalk River, Ontario. Mr. Engisch has since left the Service.

2/ Fire Research Officer, Canadian Forestry Service, Ontario Region, Sault Ste. Marie, temporarily working at Petawawa Forest Experiment Station.

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.

4/ Canadian Forest Fire Weather Index. Canadian Forestry Service. Cat. No: Fo42-4670. 25 p.

by hand or by computer) can be judged.

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; the remaining 4k are available 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
CW	-	Constant Wind (used in FFMC only, standard value 8)
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)
PO	-	Yesterday's DMC
R	-	Rain fall (inches)
SI	-	Initial Spread Index
T	-	Temperature (°F)
W	-	Wind speed (m.p.h.)

The program requires one data input tape. The first part of the tape contains the information required for the four dimension statements and all the required starting values for the season's run. The four dimension statements include the number of days in each month (LMON) and three series of daylength factors: EL, used in the calculation of the duff moisture code; FL, used in the calculation of the drought code; and DL, used in the calculation of the fine fuel moisture code. The values for EL and FL are the same as those used in Simard's program and are shown in the example on page 5 of this Report. For research purposes an allowance for fine fuel daylength factor (DL) is incorporated into the calculation of the FFMC. Since daylength is not incorporated into the standard version of the FFMC, the DL values are simply listed as 1·00 in this standard version. The standard starting values of the three moisture codes (FO, PO, and DOT), required to begin the season's run, are also listed here.

The months of the year are numbered from 1 to 12, and M and N represent the first and last month for which data have been collected. LMON, M, and N must be listed to coincide with each year's field data. For example, if the data start on April 23 and run to October 31, then LMON for the fourth month would be 8 and M and N would be 4 and 10 respectively.

The second part of the tape is the daily noon weather and includes temperature, relative humidity, wind speed, and rainfall. The printout for the first month always starts at day 1 (see sample printout). Thus, if the year's data start on April 23, the eight April days will be numbered 1 to 8, not 23 to 30.

The program prints column headings and numerical output in the following order: day and month (J, I), temperature (IT), relative humidity (IH), wind speed (IW), rain fall (R), Fine Fuel Moisture Code (FFM), Duff Moisture Code (DMC), Drought Code (IDC), Initial Spread Index (SI), Adjusted Duff Moisture Code (ADMC), and Fire Weather Index (FWI).

INPUT

This is an example of the data required on the first part of the input tape.

LMON	EL	FL	DL
31	6.5	-1.6	1.00
28	7.5	-1.6	1.00
31	9.Ø	-1.6	1.00
8	12.8	1.Ø	1.00
31	13.9	3.Ø	1.00
3Ø	13.9	5.3	1.00
31	12.4	6.4	1.00
31	1Ø.9	4.9	1.00
3Ø	9.4	2.Ø	1.00
31	8.Ø	Ø.Ø	1.00
3Ø	7.Ø	-1.6	1.00
31	6.Ø	-1.6	1.00

STARTING VALUES

FO - 85.Ø

PO - 6.Ø

DOT - 15.Ø

M (FIRST MONTH)	N (LAST MONTH)
4	1Ø

OUTPUT

DATE	TEMP	RH	WIND	RAIN	FFMC	DMC	DC	ISI	ADMC	FWI
4 1	39	98	9	.35	25.4	2.6	4	.1	2.4	.0
4 2	45	34	11	.42	54.8	2.0	2	.6	1.7	.2
4 3	54	23	7	.00	78.4	4.5	6	1.8	4.2	.7
4 4	50	28	9	.00	85.6	6.5	8	4.9	6.2	4.1
4 5	71	22	8	.00	91.7	10.8	13	10.1	10.4	10.4
4 6	73	42	8	.00	91.2	14.1	18	9.5	13.8	11.3
4 7	59	62	3	.00	88.6	15.6	22	4.4	15.3	6.1
4 8	49	67	4	.03	82.0	16.4	25	2.1	16.2	2.8

DATE	TEMP	RH	WIND	RAIN	FFMC	DMC	DC	ISI	ADMC	FWI
5 1	38	42	19	.35	58.7	9.0	15	1.4	8.8	.8
5 2	51	23	10	.00	79.7	11.4	19	2.7	11.2	2.9
5 3	43	96	10	.00	75.0	11.5	22	1.7	11.3	1.5
5 4	40	34	17	.08	70.2	10.6	24	2.2	10.5	2.1
5 5	45	40	5	.00	78.8	11.9	27	1.6	11.8	1.4
5 6	38	91	11	.55	30.5	5.4	8	.1	5.2	.1
5 7	40	83	4	.89	24.4	2.3	3	.0	1.9	.0
5 8	45	64	5	.03	48.9	3.0	6	.3	2.9	.1
5 9	44	93	4	.66	18.3	1.0	3	.0	1.1	.0
5 10	44	71	9	.31	38.4	.6	3	.2	.8	.1
5 11	50	53	11	.00	65.5	2.0	7	1.0	2.3	.3
5 12	53	98	2	.56	12.1	.4	4	.0	.6	.0
5 13	47	79	11	.44	34.5	.5	4	.2	.8	.0
5 14	51	81	12	.18	42.0	.6	4	.3	.8	.1
5 15	58	94	3	.61	18.0	.2	5	.0	.4	.0
5 16	57	40	9	.00	63.7	2.6	9	.8	3.0	.3
5 17	67	41	10	.00	82.2	5.8	15	3.5	5.8	2.7
5 18	54	40	11	.00	85.9	7.9	19	5.9	7.9	5.7
5 19	50	41	10	.00	86.7	9.6	23	6.1	9.6	6.4
5 20	61	32	5	.00	89.0	12.7	27	5.5	12.7	6.8
5 21	66	36	6	.00	89.6	16.1	33	6.5	16.0	8.8
5 22	84	46	6	.00	89.7	20.4	40	6.5	20.2	10.1
5 23	74	54	8	.00	89.1	23.3	46	7.1	23.2	11.6
5 24	65	44	9	.04	84.6	26.2	52	4.3	26.1	8.1
5 25	52	60	9	.00	84.6	27.5	56	4.3	27.4	8.4
5 26	50	64	5	.05	74.3	28.5	59	1.1	28.4	1.8
5 27	60	50	4	.12	65.0	24.2	61	.6	24.4	.6
5 28	65	35	4	.00	81.6	27.5	67	2.0	27.5	4.0
5 29	54	88	4	.20	40.7	17.8	64	.2	21.0	.1
5 30	61	46	5	.00	69.7	20.3	69	.8	23.4	.8
5 31	69	59	14	.00	81.4	22.6	75	4.4	25.7	8.2

THE PROGRAM

```
C     ADAPTATION OF SIMARD'S PROGRAM TO CALCULATE CANADIAN FOREST
C     FIRE WEATHER INDEX FOR A DIGITAL PDP 8L AT P.F.E.S.
      DIMENSION LMON(12), EL(12), FL(12), DL(12)
      WRITE(1,1004)
1004  FORMAT('PROGRAM NO.  G-5'//)
C     READS CONSTANT WIND VIA THE TELETYPE
      READ (1,2)CW
2     FORMAT(F3.0)
100   FORMAT(I2,2F4.1,F4.2)
101   FORMAT(3F4.1,F4.2)
102   FORMAT(3F6.1,2I2)
C     READS LENGTH OF MONTHS, AND DAY LENGTH FACTORS
      DO 20 J=1,12
      READ(2,100) LMON(J), EL(J), FL(J), DL(J)
20    CONTINUE
C     READS INITIAL VALUES OF FFMC, DMC, DC, STARTING AND ENDING MONTHS
      READ(2,102) FO, PO, DOT, M, N
      DO 25 J=M,N
      NN=LMON(J)
      WRITE(1,1003)
1003  FORMAT(/,/,/,/,/,/,/,/,/,/,/,/,/)
      WRITE(1,1002)
1002  FORMAT(' DATE   TEMP  RH   WIND  RAIN   FFMC   DMC     DC     ISI
     1     ADMC   FWI',/)
      DO 301 I=1,NN
      READ(2,101)T,H,W,R
```

```
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-0.225) 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.))-0.10*(T-70.)
        IF(WMO-ED) 26, 27, 28
26      EW=0.597*(H**0.768)+(14.0*EXP((H-100.)/8.))-0.10*(T-70.)
        IF(WMO-EW) 29, 27, 27
27      WM=WMO
        GO TO 30
28      Z=0.424*(1.-(H/100.)**1.7)+(0.088*(CW**0.5))*(1.-(H/100.)**8)
        X=Z*DL(J)*(0.242*(2.718**(0.0202*T)))
```

```
      WM=ED+(WM0-ED)/10.**X
      GO TO 30
29    WM=EW-(EW-WM0)/1.9953
30    WC=10.33*W**.333+0.233*FR-0.1165*FR*W**.333-20.66
      FFM=101.-WM+WC
      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(PO)
      GO TO 55
53    B=6.2*ALOG(PO)-17.2
55    WMR=WMI+(1000.*RW)/(1.92+B*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(0.0811*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    IDC = (DC+0.5)
```

```
      IT = (T+0.5)
      IH = (H+0.5)
      IW = (W+0.5)
      WRITE(1,1001) J,I,IT,IH,IW,R,FFM,DMC,IDC,SI,ADMC,FWI
      FO=FFM
      PO=DMC
      DOT=DC
301   CONTINUE
25    CONTINUE

1001  FORMAT(2I3,2I5,I6,F7.2,2F7.1,I6,2F8.1,F7.1)
      STOP
      END
```