ATTACHMENT 7D

COMPUTERIZED AGRICULTURAL CROP FLOOD DAMAGE ASSESSMENT SYSTEM (CACFDAS) YAZOO BACKWATER AREA, MISSISSIPPI

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MICROCOMPUTER VERSION OF "THE COMPUTERIZED AGRICULTURAL CROP FLOOD DAMAGE ASSESSMENT SYSTEM"

MODIFIED BY

JAMES D. GILES
INFORMATION TECHNOLOGY LABORATORY
WATERWAYS EXPERIMENT STATION
VICKSBURG, MISSISSIPPI

PREPARED UNDER CONTRACT NUMBER DACW39-86-P-0603
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OF THE VICKSBURG DISTRICT, U.S. ARMY CORPS OF ENGINEERS

INTRODUCTION

1. This documentation provides additional information on the microcomputer version of "The Computerized Agricultural Crop Flood Damage Assessment System" (CACFDAS) program. This documentation serves as an extension to the user guide section (Chapter 6) found in the documentation entitled "Deterministic Event-Oriented Computer Simulation Historical Flood Damage Assessment System."

2. CACFDAS is a program which attempts to more accurately evaluate flood damage to agricultural crops. The program utilizes historical flood data on a daily basis, current budget data, present cropping patterns, and production techniques, including crop replanting and substitution, as well as other relevant data, to assess these damages.

MODIFICATION OBJECTIVES

3. CACFDAS has been modified to run on the IBM PC or an IBM PC compatible system instead of a mainframe system such as the Harris. The revised model has also been modified to include user-friendly techniques to prompt the user for input file names and to provide an output menu for the user to select the desired output device.

INSTALLATION INSTRUCTIONS

SOURCE INSTALLATION

4. The new computer modes exist on floppy disks. It may be installed on an IBM PC or IBM PC compatible system by using the MS-DOS copy command. It is important to note that the new version can only be executed using the MS-DOS Operations System, although other software packages can be used to install the source (i.e., Wordstar). The new model can be installed either on the hard disk or on another floppy disk for backup purposes.

5. Insert the source in drive A. Assume the default drive is the hard disk. The command:

COPY A: CACFDAS.EXE (PRESS RETURN)

copies the file CACFDAS from drive A to the default drive with no changes in the filename. If you wish to install the source on drive A or drive B, then the destination drive must be specified. Insert the source in drive A. The command:

COPY A: CACFDAS.EXE B: (PRESS RETURN)

copies the file CACFDAS.EXE from drive A to the B: drive specified by B: with no change in the filename. For additional information concerning these procedures, refer to the MS-DOS Reference Manual.

INPUT FILES

6. The three sets of data files utilized and their formats are described by the documentation mentioned earlier, "Deterministic Event-Oriented Computer Simulation Historical Flood Damage Assessment System." The input files format have not been changed, and the formats must be followed to ensure proper execution of CACFDAS. The input file may be created using any software package the user chooses.

EXECUTION PROCESS

EXECUTION COMMAND

7. The initial execution of CACFDAS is the point where the majority of the modifications have been made. CACFDAS will now prompt the user for the names given to the input data files by the user. These files must already exist either on floppy or on the hard disk. CACFDAS is executed by typing:

CACFDAS (PRESS RETURN)

8. If you choose to execute CACFDAS from a floppy disk, then the disk drive must be specified (i.e., B:CACFDAS).

REQUEST FOR DATA FILENAMES

9. The user-friendly techniques incorporated in the microversion are used to request the data filenames used in the model. The following request will be printed:

ENTER FILENAME FOR DAILY ROUTING DATA?

"PRESS RETURN" TO CANCEL INPUT.

10. The user will enter the filename he has assigned to the Daily Routing data. It is not necessary for the input data filename to be unique. The user may give the input file any name he or she chooses. What is important is that the appropriate file is assigned to its corresponding request. Remember, if the data files are on floppy disk, the appropriate disk drive must be specified. For example, in response to the above request, the user would type:

A:GYSHYD.LMM
(This is a sample filename; the user may choose his or her own.)

11. If the file is not found, the program will prompt the user to try again:

FILE NOT FOUND, TRY AGAIN!

ENTER FILENAME FOR DAILY ROUTING DATA?
"PRESS RETURN" TO CANCEL INPUT.

12. Otherwise, it will proceed by requesting the two remaining data files:

ENTER BUDGET DATA FILENAME?
"PRESS RETURN" TO CANCEL INPUT.
A:TVBUD86.LM

ENTER CROP DATA FILENAME?
"PRESS RETURN" TO CANCEL INPUT
A:GYS86INP.LMM

13. CACFDAS also allows its users to cancel the data file input procedure at any point by pressing the "RETURN" or "ENTER" key, which would cause the program to terminate. To restart the process, you must execute the program again.

OUTPUT OPTIONS

14. Finally, after all requests for input data files have been met, CACFDAS will print an output menu for the user to select his desired output. The user has four options to choose from:

OUTPUT MENU

1 – OUTPUT TO DISK
2 – OUTPUT TO LINE PRINTER

PRESS "RETURN" – DEFAULT TO LINE PRINTER
TYPE "EXIT" – CANCEL PRINT

MAKE SELECTION?

1. Output to Floppy or Hard Disk Option. The user may choose any one of the output options above. If the user chooses Option 1, then this option assigns the output to floppy disk. The user now will be prompted for a filename to assign output. If the selected output device is a floppy disk, the disk drive must be specified.

ENTER FILENAME FOR OUTPUT?
GRAVEYS.LMM (sample filename; user may choose his or her own names)

There is not a need to create the output file before this option is reached. It will be created automatically.

2. Output to the Line Printer/Default Option. If the user chooses Option 2, the output is assigned to the line printer. The default option accomplishes the same task. If the user presses the "RETURN" or "ENTER" key, the output will default to the printer.

3. Cancel Print. If before selecting an option for output the user decides not to output the result of the execution, the user may type "EXIT" and then press "RETURN" to abandon the output process.

OUTPUT MENU

1 - OUTPUT TO DISK
2 - OUTPUT TO LINE PRINTER

PRESS "RETURN" – DEFAULT TO LINE PRINTER
TYPE "EXIT" – CANCEL PRINT

MAKE SELECTION?
EXIT

If an improper selection is made, CACFDAS will acknowledge this fact with the following message:

ERROR MAKING SELECTION, TRY AGAIN!

This message will continue until an appropriate selection is made. At this point, CACFDAS will begin printing its execution.

UPDATED JULY 1981

A DETERMINISTIC, EVENT-ORIENTED COMPUTER SIMULATION HISTORICAL FLOOD DAMAGE ASSESSMENT SYSTEM

BY
WALLACE E. KILLCREAS

PREPARED UNDER CONTRACT NUMBER DACW38-81-P-1650
FOR VICKSBURG DISTRICT, U.S. ARMY CORPS OF ENGINEERS

A DETERMINISTIC, EVENT-ORIENTED COMPUTER SIMULATION
HISTORICAL FLOOD DAMAGE ASSESSMENT SYSTEM

Table of Contents

Table of Contents

LIST OF TABLES

LIST OF TABLES

LIST OF FIGURES

A DETERMINISTIC, EVENT-ORIENTED COMPUTER SIMULATION HISTORICAL FLOOD DAMAGE ASSESSMENT SYSTEM

INTRODUCTION

1. Economic evaluations of the effects of flooding of agricultural areas have become an increasingly essential input in determining the feasibility of water resources projects. Major administration and congressional decisionmaking depends heavily upon the reliability of estimates of flood damages in an area, as well as the estimated benefits realized from installation of water resources development projects. Decisionmaking is enhanced by improving the calculation procedure, resulting in better estimates of damages and benefits for determining and selecting improvement projects. Also, today's conditions of runaway inflation, devaluation of the dollar, scarce resources, and efforts to balance the Federal budget, as well as other pressures to hold down Federal spending, increase the importance as well as the magnitude of determining the most productive investment of water resources monies.

2. Accurate assessment of flood damages to agricultural crops is a difficult task. The difficulty stems from the flood event occurring over a large number of crops produced in a given area, the critical timing of cultural practices involved in each crop production cycle, and the crop replanting and substitution alternatives available to farmers, as well as other factors.

3. A program, "The Computerized Agricultural Crop Flood Damage Assessment System" (CACFDAS), is an attempt to more accurately evaluate flood damages to agricultural crops. The program utilizes historical flood data on a daily basis, current budget data, present cropping patterns, and production techniques, including crop replanting and substitution, as well as other relevant data, to assess these damages. Data from this program provide the means to assist in developing the nation's water resources by improving the accuracy of economic evaluations, increasing their reliability for decisionmaking by the public, Congress, and the Federal agencies involved in the evaluation process.

ACKNOWLEDGEMENTS

4. The author is very grateful to Ms. Velma Jo Barham for her expert help in typing and arranging this manuscript and Mr. Jesse McDonald, U.S. Army Engineer Division, Lower Mississippi Valley, for helpful suggestions.

OBJECTIVE

5. The overall objective of this system is to accurately assess flood damages to agricultural crops. Potential future crop damages from flooding in a given area are specifically unknown. However, accurate estimates of potential damages can be obtained by quantifying past flood events and marrying this information with current knowledge of the agricultural crop production system. More specifically, the objectives of the CACFDAS system are as follows:

a. Develop computerized agricultural crop budgets that include current technology and allow flexible adjustments to yield levels, factor quantities and prices, and product quantities and prices. (Completed in a separate paper prepared by Dr. Bob Eddleman and Mr. Steve Henning.)

b. Analyze the effects of physical factors such as depth, duration, and seasons of flooding on crop-specific flood damages. (Completed by Dr. Bob Eddleman and Mr. Steve Henning.)

c. Develop a system for coupling the budget data to the crop flood damage analysis to allow close monitoring of flood dates and acres flooded, cultural practices on operations completed, and costs incurred for the typical set of crops found in the Alluvial Valley of the Mississippi River.

d. Develop procedures for allowing alternative crops to be installed to permit crop substitution when floods extend beyond usual or normal planting dates, when floods destroy an installed crop, or when any other existing condition prohibits production of an originally intended crop.

e. Develop the capability to partition floods into bands of inundation from daily gage recorded stage data, and therefore allow for a more realistic quantification of damage-duration factors.

f. Accommodate digitized stage-area input data in the computerized system.

g. Provide outputs of crop-specific damages from production costs, damages from foregone net revenue, and total damages, as well as total banded acres flooded, damages per banded acre flooded, total acreage in flood peaks, and damages per flood peak acre.

DEFINITIONS

6. Some of the terminology used in the development of this system has special meaning for this system only. In the interest of clarity and brevity, a set of definitions follow.

a. Reach. .A reach is a specific geographically defined land area to be analyzed by the damage assessment program.

b. Flood. A flooding event covering a period of N consecutive days. For computational purposes, an assumed drying out period separates each flood. A 10-day dryout period was assumed for examples in this book, but any dryout period desired can be read in on a reach header card. If a flood begins in one calendar year and ends in the next calendar year, it will be split into two parts, with the first part ending on December 31. The second part would begin on January 1 of the following year. All damages are aggregated in the calendar year of their occurrence.

c. Minifloods or bands. Bands are developed by evaluating outside points (points on the head or the tail) of digitized stage inputs, point-by-point. The lowest outside point is always evaluated next. Each point represents 1 day of flooding. When a dryout period occurs within a daily band, it is divided into tenths. The one-tenth day band areas are accumulated until one-tenth day portion is developed that contains a dryout. Damages are assessed on the accumulated area, then the remaining one-tenth day bands are separately evaluated, giving results that are extremely sensitive to changing shapes of flooded areas.

d. Flood year. The summation of all floods occurring during a calendar year (January 1 – December 31) for spring crops and from August 1 to July 31 for winter crops. The assumed crop distribution for the reach is used for the first flood in a flood year. Subsequent floods are based on the initial distribution as well as the damage history to date during the flood year.

e. Banded acres flooded. This is the summation of all flood bands developed. Banded acres will always be as much as, and will usually exceed, the total acreage in flood peaks. When dryouts (10 days in this example) occur within a given flood, this increases the acreage in bands. Consider Figure 1. In Illustration A, 40 acres are flooded for 26 days because the dryout period is less than 10 days. Banded acres, therefore, amount to 40 acres. Now, look at B. Here we have 40 acres flooded for 4 days, plus 40 acres flooded for 12 days. Although the potential for damages is generally higher in A because of the 26-day critical duration, the banded acres flooded in B are twice that in A, totally due to 2 less days flooded (10-day dryout). Damages could conceivably be higher if the critical duration is low. In these examples, damages in B would be double that in A if the critical duration is 4 days or less; A and B damages would be equal if the critical duration is between 5 and 12; if the critical duration is greater than 12, B damages would be zero, while A damages would be based on 40 acres flooded.

f. Acres damaged. Those banded flood acres on which the duration of flooding is long enough to cause damages. This acreage is crop-specific. Peak damaged acres (acres flooded when damage was incurred by a given crop) are maintained by crops within each flood year so that double counting can be avoided. Once a crop is lost, no further damages are assessed during

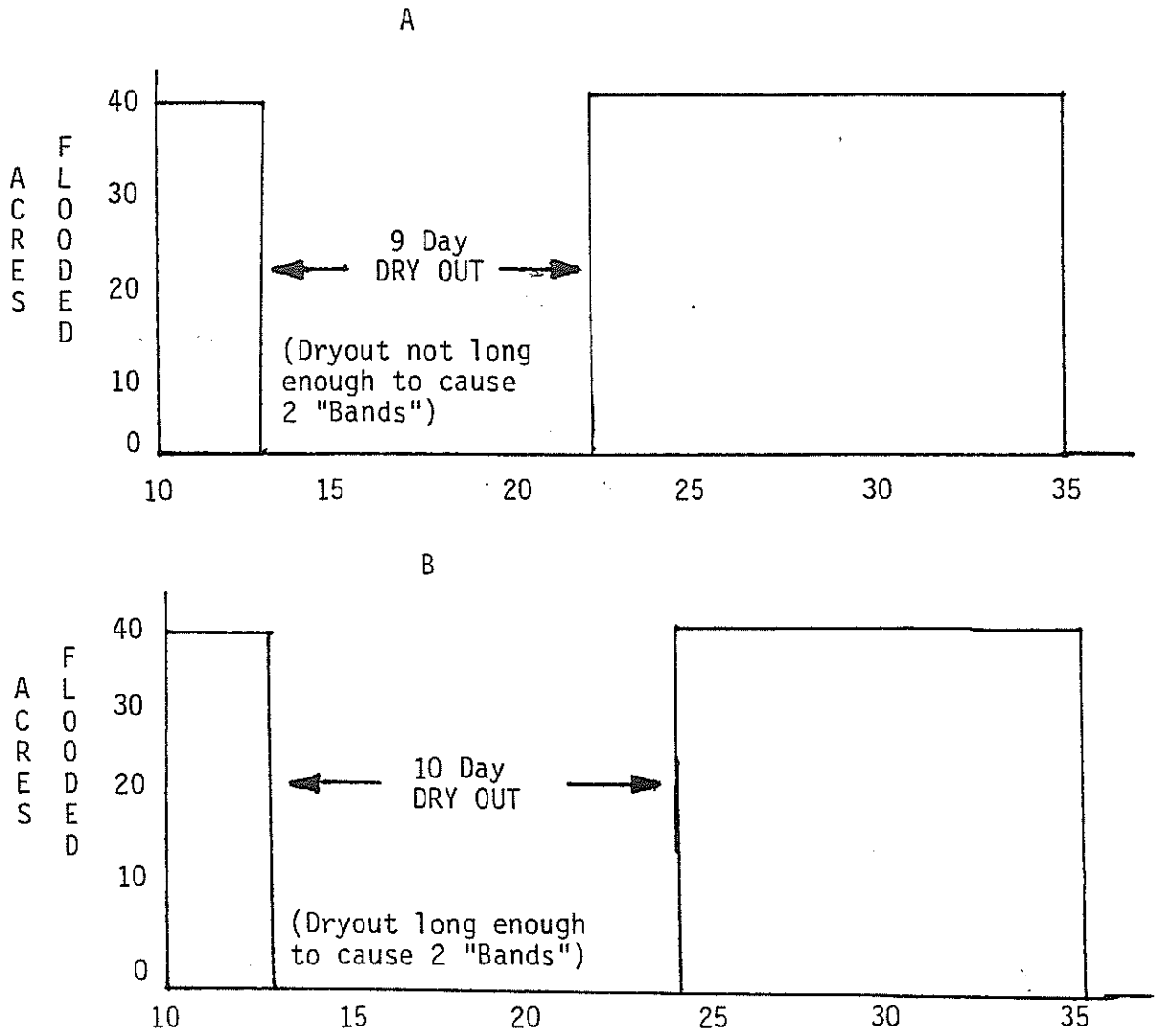


Figure 1. Illustration of the effects of a dryout period on the number of bands generated.

that flood year. Acreage distributions are generated based on the flooding history within a given flood year. Included in the history would be acres damaged, lost, or replanted by crops. Acreages shown as damaged in Table 4 (net annual acres damaged) include replanted acres, lost acres, and forage crop acres damaged.

g. Peak acres flooded. The greatest acreage flooded within each flood. The summation of peak acres for all floods within a reach will generally be greater than acres damaged and less than banded acres flooded.

h. Crop distribution. Percentages of each crop grown in a particular reach. These percentages would sum to 100 percent if all acres in the reach are cultivatable. These percentages must be supplied at program execution time. Initial acres flooded are assumed to follow this crop distribution. In special cases where more than one crop is planted on the same land area, crop percentages can exceed 100 percent. There is a special "flag" on the reach header card image that allows for "overbooking" the land. This facilitates definition of double crops.

i. Initial acres flooded. That portion of flood band acres that have not been flooded by prior floods during the current flood year.

j. Replant acres. That portion of acres damaged that have been successfully planted in some alternative crop. Replant acreages can be replanted as long as planting dates permit. A replanted replant would show acreages in alternative crops as they were after the last flood during the flood year. Damages are cumulative as acreages are replanted.

k. Acres lost. Flood band acres which have no alternative crops available. Acres placed in this category will add to damages when they are placed in it, but no future gains or losses are computed for these acres during the flood year.

l. Acres damaged, but not replanted. Crops which could contribute to this category include certain forage "crops" such as hay and pasture.

m. Julian dates. A system for generating dates between 1-365 for a given calendar year (1-366 for leap year). Dates used in crop budgets must generate Julian dates in ascending sequences.

n. Winter crops. Those crops whose beginning date is August 1. All other crops have a beginning date of January 1. Winter crops have a "W" coded in Field 3 (Column 10) of crop header cards. Computations will reflect the date difference for winter crops. Different crop years affect damage computations because computations for the first flood of a given flood year

are associated with the assumed initial crop distribution, while subsequent floods during a flood year are dependent upon both the initial crop distribution and the replanted and lost acres accumulated to date during the flood year.

o. Flood damage tables. Flood damage tables consist of costs, percentages of gross revenues, and critical durations by Julian dates for each crop.

p. Expected net revenues. The difference between gross revenues and costs. One expected net revenue value is provided for each initial crop.

q. Expected gross revenues. The summation of gross revenues for each crop. One value is supplied for each crop. This value is used in conjunction with the summation of percentages harvested to determine revenues realized prior to flooding for a particular crop.

r. Minimum field operation date prior to a replant. The Julian date associated with the last field operation assumed by replant flood damage tables. This date relates to initial crops only. Usually corresponds to the last activity prior to planting.

s. Last date of replanting. This critical Julian date is provided for each replant crop and is used to determine whether or not the crop can be replanted.

t. Planting date for initial crops. This is the "normal" planting date and if a flood ends (including dryout time) before the planting date, no damage will be assessed. This date should not be supplied for winter crops, pasture, and hay.

u. Program. The complete set of computer programs written to support this flood damage assessment system.

v. Crop numbers. Relates to the set of flood damage tables associated with the crops included in this computerized system. Crop numbers are assigned for computational convenience. Flood damage table numbers appear below as they relate to crop damage computational categories.

w. Partial damage percentage. If a flood occurs during the life cycle of a crop (planting through harvest), but the duration of the flood is not sufficient to cause damages normally assessed, partial damages are possible. A percentage of potential damages (if the duration had been critical) can be assessed for partial damage. This percentage is read in on the reach header card.

7. The crop definitions stated below are hypothetical; user-defined definitions for a particular cropping pattern are expected. Budgets for the crops stated below were developed in the original U.S. Army Corps of Engineers, Vicksburg District-Mississippi State University study.

CROP DEFINITION AND KEY TO CROP NUMBERS

Crop Number	Crop Description
Spring Crops	
1	High management rice
2	Typical management rice
3	High management cotton
4	Typical management cotton
5	Typical management cotton replant
6	High management soybeans
7	Typical management soybeans
8	Typical management soybeans replant
9	Low management soybeans replant
10	Soybeans, as part of typical management wheat-soybean double crop
14	Typical management grain sorghum for grain
15	Typical management grain sorghum for silage
16	Typical management corn for grain
17	Typical management corn for silage
18	Tomatoes for processing—direct seed
19	Tomatoes for processing—replant
20	Cucumbers for processing
21	Cucumbers for processing—replant
22	Protopea for processing
23	Protopea for processing--replant
24	Irish potatoes
25	Turnip greens for processing

Crop Definition and Key to Crop Numbers (Cont)

Crop Number	Crop Description
Winter Crops	
11	Typical management wheat for grain
12	Typical management wheat annual grazing
13	Typical management oats annual grazing
26	Wheat, as part of typical management wheat-soybean double crop
Forage Crops	
31	Coastal Bermuda pasture maintenance
32	Common Bermuda pasture maintenance
36	Coastal Bermuda for hay
37	Common Bermuda for hay

8. The crop definitions given on this page may be utilized to define a particular cropping pattern. Care must be taken that the crop numbers defined be used only for the type of crop given in the list below.

9. Here is a key to crop definitions:

Crop Coding Conventions

Crop Type	Crop Numbers Available
Initial Field Crop	1, 2, 3, 4, 6, 7, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, 22, 24, 25, 26
Field Crop Replants	5, 8, 9, 19, 21, 23, 27, 28, 29, 30 (crop numbers 27-30 allow for replant crop expansion)
Pasture Crops	31, 32, 33, 34, 35 (three additional slots have been defined for forage crops)
Hay Crops	36, 37, 38, 39 (two additional slots for hay crops have been defined)

10. Winter crops are defined by coding a "W" in column 10 of the crop header card (see card type 4 of the user's guide). They should include a January 1 budget extension entry for all costs and/or revenue percentages occurring between August 1 and December 31. These same costs/revenue percentages should also be included as events between August 1 and December 31. The program will avoid double counting these damage table entries. Also, a December 31 budget extension entry is needed (Julian Date 365, zeroes for costs, revenue percentages ,and sum critical duration as January 1 entry) to implement budget continuity. This applies to all winter crops.

ASSUMPTIONS

11. The assumption was made that up-to-date crop budgets would be available prior to analyzing each project. The budgeting technique used allows revisions due to product price changes in a rather straightforward way. Across-the-board changes to factor prices can be made, but price changes for specific cost items require that budget generator runs be made prior to flood damage table updates.

12. It was assumed that the initial crop distribution at a reasonable level of accuracy for each reach to be analyzed is known prior to analysis. This distribution must be reasonably accurate, and the resulting damage assessment from operation of this set of simulation programs is no better than the assumed initial crop distribution. Estimation of crop distribution data that are sensitive to differences in elevations and soil types could well be a research effort in itself.

13. Data-relating floods to specific days (digitized stage input data) were assumed to be available at an acceptable level of accuracy prior to analyzing each reach.

14. Alternative crops were assumed to be known each time an analysis is performed. The program allows flexibility with respect to specification of alternative crops. Currently, up to three alternative crops can be specified. This is done by defining the initial crop number, followed by crop numbers pertaining to alternative crops in order by crop value.

PROBLEM FORMULATION

CROP BUDGET DEVELOPMENT

15. There is a separate paper prepared by Dr. Bob Eddleman and Mr. Steve Henning addressing this subject.

COMPUTER PROGRAM DESIGN

16. Computer programs developed for damage assessment are written in FORTRAN V. Core storage requirements are about 25K on a 36-bit word machine.

17. Two disk files are required as inputs to the program. The amount of disk space required is dependent upon the amount of digitized stage input data to be processed.

18. There are three operational modes of the program.

a. "Normal" or "flood" mode. Reports are generated for each flood, for each flood year, and for a reach summary.

b. "Brief" mode. Flood year reports are produced, as well as a reach summary.

c. "Debug" mode. All reports from above are generated, plus very detailed debugging information, which is available down to the "band" level within each flood.

THE COMPUTERIZED SYSTEM IN OPERATION

DATA CONSIDERATIONS

19. Specific formats for all data inputs are defined in Section E, the user's guide. Explanations of what each datum is used for during program operation are delineated in this section.

Flood Damage Tables

20. Flood damage data consist of crop-specific costs, incomes, and critical duration information, in order by Julian dates. These data are contained in a file that is organized around field operations. Each entry in the file represents a necessary cultural practice for a specific crop. Exceptions to this include interest on operating capital and budget extension entries, which are necessary bookkeeping entries.

21. Dollars are used to depict crop costs, and harvest percentages which are relatable to gross revenues represent crop incomes. Harvest percentages facilitate changing the income flow for a particular crop simply by changing one gross revenue value. Costs and incomes are averaged

over each period. If a given initial field crop (winter crops excluded) is not assumed planted after allowing for the flood and a dryout period, no damages are assessed.

22. The critical duration data in the flood damage tables are used to determine whether the length of each flood band or band fragment is sufficient to cause damages. Each flood band that is of a longer duration than the critical duration in appropriate Julian date and crop-specific flood damage table entries will cause damages. If the flood band duration is shorter than the critical duration, then the flood band is ignored. If a flood band encompasses more than one flood damage table entry, the smallest critical duration is used to determine whether or not damages should be assessed. For initial field crops (see crop coding conventions, page 12), critical durations prior to the planting date are not needed. Flood damage tables for high management cotton and high management soybeans are included in Appendix 8.

23. Since costs and income flows are averaged over the time period encompassed by each flood damage table entry, costs and incomes associated with each entry are assumed if a flood band occurs during any portion of the time period of the entry (provided the flood band duration is as long or longer than the critical duration associated with the flood damage entry).

Initial Crop Distribution

24. These data consist of crop number-percentage of land area combinations. Only those initial crops that are assumed to be present in the reach are included. In aggregate, these data generate the initial cropping pattern. The initial cropping pattern is assumed at the beginning of each flood year (January 1 for spring crops and August 1 for winter crops).

Net and Gross Revenues

25. Expected net revenues, which are needed for all initial crops, reflect the difference between expected gross revenues and the total expected cost flows for each crop. These values represent returns to land and management, as well as lost opportunities when the crop is lost and no alternative crops are available.

26. Gross revenues are designed to reflect total anticipated crop incomes. If product prices change, up-to-date flood damage tables can be obtained by changing gross revenue values (one value per crop). Net revenue values will necessarily be changed for initial crops when the gross revenue value is changed (net revenue = gross revenue-costs).

Alternative Crop Data

27. Initial crop numbers are associated with first, second, and third alternative crops. All replant activities are assumed to be different crops for programming purposes. Some initial crops have only one alternative. A few initial crops have no alternatives and do not appear in the set of alternative (replant) crop data.

Planting, Last Date of Replanting, and
Minimum Field Operations Dates

28. These data are all in Julian date format. The planting date is the "normal" planting date for initial crops only. The last date of replanting is the last possible day that the crop could be replanted (replant crops only). If the last day of flooding, plus the dryout period, is a larger Julian date than the last date of replanting date for a given replant crop, then the crop being examined cannot be replanted. If none of the alternative replant crops available can be planted, then the flooded crop is lost (no replant is possible).

29. The minimum field operations date corresponds to the last field operation prior to planting (initial crops only). Most replant flood damage tables assume that all field operations prior to planting have been done. If a crop is to be replanted and the assumed necessary operations were not performed prior to the flood, then costs of performing the needed operations must be incurred. The program keys on the date provided to determine if all assumed operations have been performed.

Digitized Stage Input Data

30. The simulation of flood events is based on historical data included in the digitized stage input data file. Each entry in the file consists of a date (MM DD YY) followed by acres flooded on that date.

31. This date is expected to be in sequential order over the total analysis period (years, months, and days).

Reach Header Card

32. The reach header card is read first. It is designed to provide a name for the reach, the number of years to be analyzed, and the mode of analysis (normal, brief, or debug) for report generation purposes. There is also a free format "flag" to define optional free format flood damage table inputs and an overbooking "flag" for double crops. The assumed dryout period for the reach is read in days on the reach header card. The percent of acres assumed to be partially damaged if the flood is too short to cause damage normally assessed completes reach header data.

Initialization

33. Initially, the program zeroes some matrices, then reads and stores all crop budgets (all crop flood damage data are stored in computer memory and are available throughout program execution).

34. Then, a set of crop-specific information is read and stored. This information includes initial crop distribution percentages for the reach; expected gross and net revenues by crops (these data augment flood damage tables); information relating initial crops to possible alternative crops that might replace the initial crops; and last date of replanting, planting dates, and minimum field operation dates.

35. Digitized stage input data, which must be in ascending order by dates, are used to drive the program from this point until program termination.

Damage Assessment

36. Digitized stage input data are processed sequentially to determine hypothetical damages based on previous floods and present crop distributions and prices.

37. First, the program will read digitized stage input data until a flood can be defined. This is accomplished simply by reading and storing digitized stage input (DSI) data until the assumed dryout period has been reached. The dryout period is a reach header card variable and can be any number between land 99. For purposes of this discussion, a 10-day dryout period was assumed. A flood is defined when at least a 10-day "break" is discovered (10 days is the assumed dryout period between floods) in the data. This means at least 10 flood-free days.

38. Next, the flood would be divided into bands of inundation (also called minifloods in this paper). Initial bands (Figure 2) are defined by scanning horizontally from the lowest outside point. Both the beginning and the ending of the flood are considered in this analysis. For example, Bands 1 and 2 were created from beginning (or head) outside points. Band 3 was created by an ending (tail) outside point. Notice that Bands 4-9 are all fragmented bands. That is, they each contain acreages that have 10 day (or more) dryouts. All fragmented bands are divided into tenths of the original band height so that greater sensitivity in processing unusual surfaces may be attained. Part of Band 9 is divided thusly to illustrate how sensitive the program is to fragmented surfaces. The flood duration is computed by summing the total days that the bottom of each band is flooded. For example, Band 1 was flooded 58 days (98-41+1) and Band 6 had fragments of 8, 19, and 7 days (Figure 2).

39. The purpose of banding is to account for differential dryout times associated with different elevations within a given flooded area.

40. Damage assessment is crop-specific (see list of crops, page 11), and separate flood damage tables are utilized for each initial crop and replant crop. Many computational procedures are common to all crops. There are five different computational methods that are crop-specific: (a) spring crops, (b) winter crops, (c) pasture, (d) hay, and (e) double crops. General computation procedures will be discussed first, then the five crop-specific computational methods will be discussed.

41. General.

a. Damages assessed depend upon the acreage flooded, the duration of the flood, and the assumed initial crop distribution. If multiple floods occur during the same flood year, the program keeps up with crop-specific peak acres flooded and classifies flooded acreages as either initially flooded or reflooded, with respect to damages.

b. Damage calculations on reflooded acreages are very much different from calculations on initial acreages. In fact, if the crop on any acreage has already been lost (no replant was available), no additional damages would be computed during the flood year in which the crop was lost. Replant crops generally are of lower value than initial crops. Crop-specific damages are accumulated as crops change due to flooding.

c. The smallest land area on which damages can be assessed is a band fragment. Damages are assessed on each band (or band fragment, if applicable) individually so that land areas on which damages are assessed can be depicted as accurately as possible. It is possible (and usually probable) to assess damages on one crop within a given band, while assessing no damages on

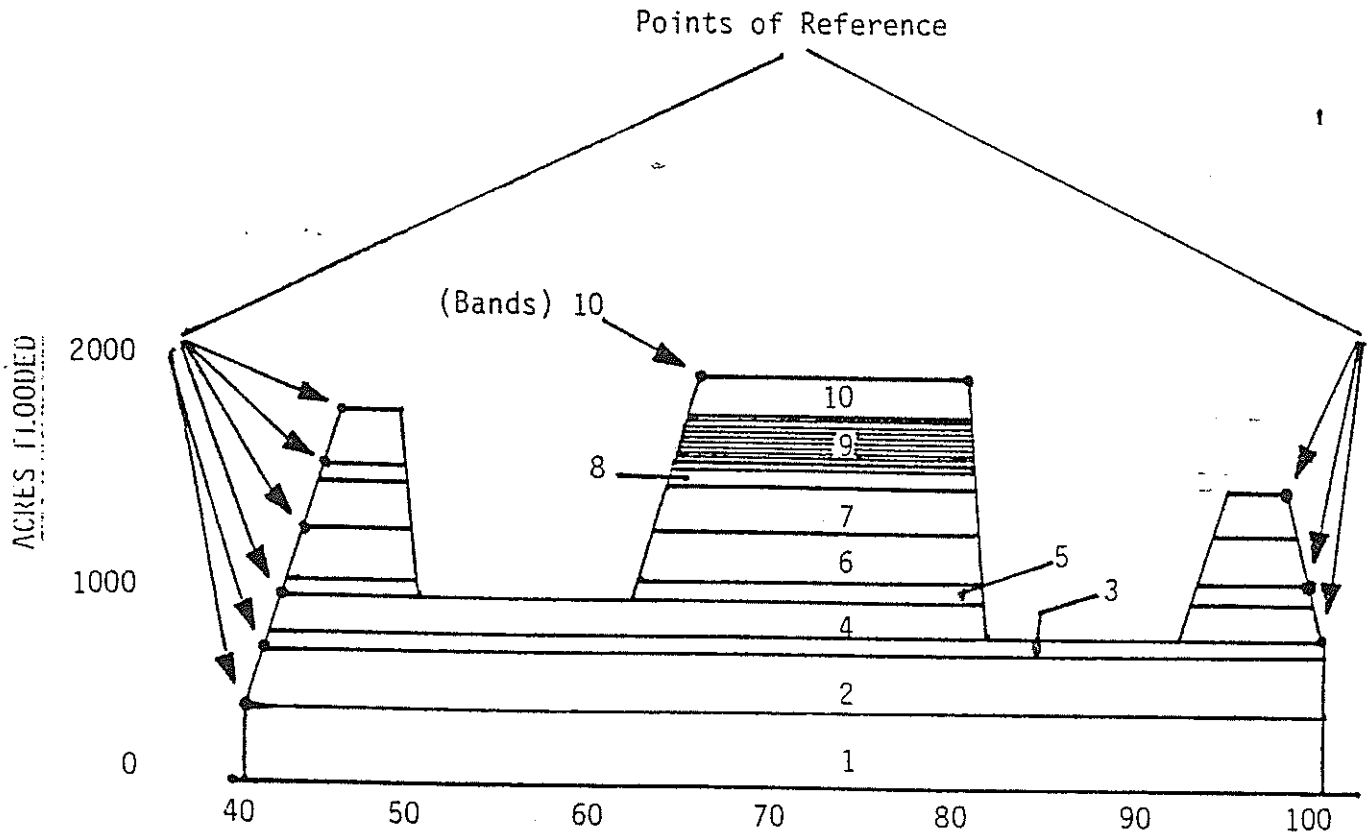


Figure 2. Division of a flood into Bands

another crop within the same band. The critical duration data within each crop budget are used to determine whether or not the duration of a given band of inundation is long enough to cause damages to be assessed.

d. The program will classify land areas making up each band into initially flooded, replanted, lost, and damaged acres.

e. In the interests of computational simplicity, all bands making up the first flood of a flood year are assumed to be initially flooded acreages.

f. Replanted acreages evolve during a particular flood year because initial crops can logically be replaced by either the same crop or a lower valued crop. Alternative crop possibilities and flood damage tables are used in conjunction with last date of replanting data to develop replant acreages and damages.

g. Lost acres consist of land on which crops have been lost and no alternatives are available. Once a land area as related to a specific crop has been classified as lost, no additional crop losses can occur during the current flood year for that crop.

h. Damaged acres is a category associated with forage crops which incur damages, but are assumed to recover after flooding. Damages are assessed in terms of lost grazing and lost cuttings of hay.

42. Spring Crops.

a. Spring crops for which budgets have been developed include rice, cotton, soybeans, grain sorghum, corn, tomatoes, cucumbers, protopea, Irish potatoes, and turnip greens.

b. Cost and revenue percentages are accumulated through the last Julian date prior to and including the flood date. If the critical duration data at any date encompassed by each band of inundation (flood days) are greater than the days flooded in each band, no damages will be assessed. If the days flooded are greater than or equal to the critical duration days, per-acre damages are accumulated as follows.

Net revenue associated with initial crop
+$\sum$of cost and revenue flow to the flood date for the initial crop (this may be a minimum operation date if a replant is installed).

c. +∑of cost and revenue flows of all replants put in place after the initial crop. If a replant is in place at the end of the calendar year, costs and revenues will be summed (costs as positive damages and revenues as negative damages) over the crops' entire flood damage table. The effect of this is that successful replants tend to generate negative net costs (profits) which recover initial crop losses. This is done in the form of adjustments (see Table 4).

d. Naturally, all replanted acres (replanted replants are counted just once) would be placed in the replanted acres categories.

e. Alternative crops are examined in a predefined order, with the most profitable crops examined first. If the ending date of the flood is greater than the "last day of replanting" date for all alternative crops, the acreage is placed in "acres lost." Acreages placed in the acres lost category are not eligible for replanting during the flood year that they were lost. If it is determined that acres lost have been reflooded, no damages (or revenues) are assessed.

43. Winter Crops.

a. Conceptually, winter crops are programmed the same as spring crops. However, a winter crop year does not fit into the framework of a calendar year. On December 31, winter crops are still growing. Example budgets for winter crops include wheat, oats, and the wheat portion of wheat-soybean double crop.

b. Therefore, the defined flood year for winter crops is August 1 to July 31. Winter crop flood damage tables each contain a dummy January 1 entry to bring all previous year costs (establishment, for example) forward to January 1. This allows floods occurring between January 1 and July 31 to be processed in exactly the same manner as spring crops.

c. When a winter crop is flooded between August 1 and December 31, flood damage analysis is begun on August 1 to avoid double counting. Flood peaks and acreages damaged are carried through December 31 and are not "zeroed' until July 31 of the following year.

d. Damages associated with winter crops are accumulated during the calendar year in which they occur.

e. Winter crops can be defined as any initial field crop number (see crop coding conventions, page 13).

44. Pasture Maintenance (coastal Bermuda and common bermuda). Crop numbers 31 and 32. Numbers 33-35 are available for additional pasture budgets.

a. Damages are assessed on the basis of lost grazing. Damaged acres would be placed in the "damaged, but not replanted" category. Per-acre damages are foregone grazing losses per day times the number of days in each miniflood (band).

b. This program uses the "revenue percentage" field (see card type 4, columns 19-28) to assess grazing losses. The percent that monthly revenue is of annual revenue is entered for the first day of each month where revenue accrues. The "costs" field (type 4, columns 9-18) is ignored. However, the costs field can be coded as a reminder of the actual losses for each period.

c. Total damages are per-acre damages times the average acres damaged.

45. Hay Maintenance (coastal bermuda and common bermuda). Crop numbers 36 and 37. Numbers 38-39 are available for future hay "crops."

a. No damages are assessed for floods occurring on noncritical days. If flooding occurs on critical days (days in which cut hay is down in the field), damages are assessed as follows: per-acre damages are a loss of all hay for that particular cutting. No other damages are assessed.

b. Total damages are per-acre damages times average acres damaged.

c. Loss of a cutting of "hay will occur if the flood date occurs between (and including) a critical day and the next operation in the hay budgets. This is currently a period of 4 to 6 days for each cutting.

d. Acres on which hay cuttings are lost are placed in the acres damaged, but not replanted category.

e. The "revenue percentage" field (type 4, columns 19-28) is used to assess cutting losses for hay. The percentage lost for each cutting is defined by the card image for the first day of the cutting. Subsequent days within a given cutting need not be coded, except for the last day of the cutting. The last day entry is needed to define the length of each cutting, and revenue percentages are not required on last day entries.

46. Double Crops.

a. Double (or triple!) crops can be defined in the same way that single crops (1 year) are defined, except that the percentage of the land used by the crop is double counted; i.e., if 10 percent of the land area is in wheat-soybean double crop, we would code a soybean crop occupying 10 percent of the land, plus we would code a winter wheat crop occupying 10 percent of the land.

b. Coding double crops in this manner frequently causes more than 100 percent of the land area to be assumed occupied by crops (hence the term "overbooking").

c. Overbooking the crop acreage is not inconsistent with this computation method since damages are assessed only in the life cycle of the crops defined. Damages on double crops for a given land percentage would be mutually exclusive, except when the crops actually overlap (example: winter wheat is flown on soybeans before they are harvested. Between the wheat planting date and the soybean harvest date, the two crops overlap).

COMPUTER PROGRAM DESCRIPTION

ORGANIZATION

47. The computer model used for flood damage is divided into a FORTRAN main program and 7 FORTRAN subroutines. Names and brief descriptions of the routines are presented below. (NOTE: Total FORTRAN statements in all routines are about 1,000 [as of December 1979]).

a. Main. The main program is the control routine. It reads in all inputs and sets up the problem. Subroutines BAND, JD, OUTPUT, ZERO, and ZEROY are called by MAIN. MAIN sets up all necessary flood damage matrices; scans digitized stage input data; defines each flood; and maintains and controls matrices for each flood, flood year, and reach. All finished reports are generated from MAIN. MAIN is about 340 statements long.

b. Band. Bands of inundation are defined by scanning forward or backward from the lowest end point of the flood. Forward scans are done when the lowest end point is at the beginning of the flood, and backward scans are done when the lowest end point is at the end of the flood. The lowest point between the two end points will be referred to as the point of reference. If they both have the same value, the point of reference chosen is the beginning point (Figure 2). All points between the two end points are scanned to see if they are less than the point chosen as the point of reference. If a dryout (N flood-free days) does not occur, the band duration is the number of points between the beginning and the end of the band, including the end points. The acreage flooded would be the difference between the current point of reference and the previous point of reference (Figure 2). When dryouts occur, each dryout period within

an initial band (see Band 6, Figure 2) generates a new band fragment. When damage computations are done, each fragment is treated as a separate band. This causes relatively more acres flooded, because each fragment contributes to the acreage analyzed. Since the duration of each fragment is relatively short, potential damages are generally low when processing band fragments. Band heights are divided into tenths when fragments occur (Figure 2, Band 9). Each one-tenth band height is processed separately. This causes very sensitive processing when irregular surfaces occur and less sensitive processing when flooded acreages are simply flooded to some peak, then the water recedes, giving a nonfragmented band.

c. Damage. The DAMAGE subroutine. It is called each time a band or band fragment has been defined, and it computes all flood damages for each crop, then updates the appropriate matrices to reflect acreage movements and damage accumulations as crops are replanted, damaged, or lost. DAMAGE updates reach, flood year, and lost. Damage updates reach, flood year, and flood matrices. In debug mode, DAMAGE will print various matrices which are helpful in determining how flood damages and acreage movements are being computed as each band, flood, flood year, and reach are processed. DAMAGE is about 330 statements long.

d. JD. JD, the Julian date subroutine is used by MAIN to convert conventional (month, day, year) dates into Julian dates. JD is 12 statements long.

e. Report. Called by MAIN to produce reports that are generated in Debug mode only. Sixteen statements long.

f. Output. This subroutine is called by MAIN to produce flood, flood year, and reach reports. It is 34 statements long.

g. Report. The REPORT subroutine produces debugging reports (matrix dumps). It is called by DAMAGE and is 16 statements long.

h. Zero. ZERO is used to set various matrices equal to zero. It is called by MAIN and is 11 statements long.

i. Zeroy. Used for zeroeing flood year matrices for winter crops. Fifteen statements long.

Programming Assumptions

48. Several assumptions were needed to implement this flood damage assessment system. They are stated and explained below.

a. Initial crop percentages, crop budgets, digitized stage input data (flooded acres for each flood day), and number of years of data to be analyzed were all assumed to be available. Flood damage tables are assumed to be in card-image format and are designed to be updated by a text editor or another computer program. Updates to the flood damage tables must be made prior to program execution. The flood damage tables (file 9) are assumed to need updating less frequently than general card inputs. The digitized stage input file is assumed to be a card-image file. It (file 8) will change with each reach. Data actually used by the programs from this file include acres flooded and dates associated with acres flooded. The crop percentages and number of years to be analyzed in the reach are assumed to be read in at program execution time. All data formats are provided in Section E, the program user's guide. Generalized card inputs (see Section E, Users Guide) include crop alternatives; expected net revenues; and gross revenues for each crop, normal planting date for initial crops, last dates or replanting for initial crops, and the Reach Control Card.

b. An N day variable dryout period between floods is read as a variable by the program and used for all acres flooded. This defines each flood, as well as causing band fragments to be defined within floods having floodwaters that rise, fall, then rise again.

c. Replanted acres generated during the current flood are not considered as replanted until the next flood. This means that during the first flood of a flood year, all acres flooded are considered to be flooded for the first time.

d. All reflooded acreages (those currently flooded that have been previously flooded during the same flood year) are pooled and then distributed based on the current year-to-date distributions associated with replants, lost acres, and damaged acres. Each acreage category receives the same weight. The acres assumed to reflood first are, of course, those acres that have been previously flooded during the current flood year.

e. When more than one flood occurs during a particular flood year, previous peak acres damaged for each crop are examined, and all acres damaged that are higher than the previous peak acres damaged are considered to be initial acres flooded. Crop-specific flood peaks are maintained as total acres flooded when damages were incurred by a given crop. Differences between current acres flooded and previous flood peaks for the crop are computed. The number of new acres flooded assumed for the crop is the computed difference in flood peaks, multiplied by the crop percentage for the crop being analyzed. Those acres associated with each damaged crop that are less than the previous peak are considered to have been previously flooded and are prorated among replants, lost acres, and damaged acres as described in d above.

f. Minimum and maximum acres flooded by quarters are computed on the basis of nonzero observations only.

THE CROP LAND ALLOCATION ALGORITHM

49. First, the general philosophy of land allocation used by the program:

a. All "acreages (the summation of all the bands) flooded" in the first flood of a flood year (January 1 to December 31, spring crops; August 1 to July 31, winter crops) are distributed as initial acres. In such a situation, acres flooded are multiplied by assumed crop percentages to obtain crop-specific acres that can be damaged if the critical duration and other factors, in conjunction with the flood date, show that damages did occur. The acres having damages can be as high as the acres allocated (acres flooded), but generally they will be lower.

b. On subsequent floods during the flood year, crop-specific replant acres, damaged acres, and lost acres, together with flood peaks, are used to determine the acreage distribution.

50. First, summations are obtained of replant, damaged, and lost acres through (and including) the last flood previous to the current flood in which the band occurs.

51. All crops which do not have flood peaks set (have not incurred damages) are allocated as initially flooded acreages based on the crop reach percentages.

52. Crops which do have flood peaks set (have incurred damages) are examined to determine if the current peak acreage (acres left + average acres flooded) is greater than the previous flood peak (peak acres flooded when damages occurred for the crop). When the current peak is higher, the difference in the two peaks (new peak - old peak) times crop percentage, up to the total acres that can be allocated to the crop based on assumed reach percentages) is allocated as initial acres flooded. If the difference is less than the acres that reachless percentages would allocate, only the difference is allocated as initial acres.

53. Once initial acres have been allocated, the difference between acres flooded and initial acres allocated is computed. This difference (acres flooded - initial acres allocated) is prorated among replant, damaged, and lost acres, depending on the magnitude of each, during the current flood year.

54. Damages are not assessed for initially distributed lost acres since they were lost prior to the current flood. Damages assessed for replant acres are generally lower than those assessed for initial acres because replant crops generally are of lower value. Damages for acreages distributed as damaged acres are exactly the same as those for initially distributed acreages since the pasture crops incur damages based on the acreage flooded and the duration of the flood only.

The only reason for keeping up with damaged acres is to make acreage movements associated with pasture crops consistent with those of all other crops.

REPORTS

55. Excerpts from reports generated by this program are presented in Tables 1-5. Different modes of program operation (normal, debug, and a brief) generate different quantities of outputs. Input data needed for generation of reports shown in Tables 1-5 are in the example problem in the user's guide following Tables 1-5.

56. In the debug mode of operation, every output that the program generates is given. These outputs include printouts of digitized stage input data; background data for the development of flood bands; and matrix dumps designed to monitor land use within flood bands and over flood years, flood reports, calendar year reports, and a reach summary report.

57. In normal or flood mode, only flood, calendar year, and reach summary reports are generated.

58. In brief mode, only calendar year reports and the reach summary are generated.

59. Tables 1 and 2 contain debug outputs that are generated only in debug mode in developing damage estimates for one flood. Reports presented in Tables 3, 4, and 5 relate to the same reach, flood, and flood year as Table 1 reports.

60. Table 1 should be read in conjunction with this section. First, crop names and crop percentages for each crop in the reach are given. Notice that 112 percent of the land area was "booked" (84 + 12 + 12 + 4). The reason for the extra 12 percent is that soybeans (double crop) and wheat (double crop) are grown on the same land. Usually less than 100 percent of the land area will be "booked" because untillable land is not assigned to a crop in this program. However, if there are double crop acreages, as in this example, more than 100 percent of the land can be "booked."

61. Next, we see Julian date acres flooded information for the first flood for the reach. The first flood started on January 3 and lasted through January 12. Since 1,000 acres was the smallest amount flooded, the height of the first flood band was 1,000, and the flood lasted for 10 days (January 3-12). Since the acreage was overbooked, we allocate 1,120 acres in initial distributions (1,000 times 1.12). Typical management soybeans were allocated 840 acres (.84 times 1,000); soybeans (double crop) 120 (.12 times 1,000); wheat (double crop) 120; and corn for grain 40 (.04 times 1,000). No replant or lost acres were allocated since this is the first flood of the year.

TABLE 1
INITIAL CROP DISTRIBUTIONS, DIGITIZED STAGE INPUTS,
LAND ALLOCATIONS, AND DAMAGES AS REPORTED FOR A FLOOD BAND

Crop Name	Percentage
Soybeans, Typical Management	84
Soybeans (Double Crop)	12
Wheat (Double Crop)	12
Corn for Grain, Typical Management	4
Julian Date	Digitized Stage Input Acres
3	1,000
4	1,000
5	1,000
6	1,000
7	1,000
8	1,000
9	1,000
10	1,000
11	1,000
12	1,200

End of Band. Start: 3 End: 12 1,000 acres flooded

Yearly Flood Year Acreages Prior to This Mini Flood

Acres left = 0.00 Starting JD of Mini Flood = 3.0 Duration of Mini Flood = 13.0
Mini Flood: Avg A = 1,000 Replant A = 0.00 Damaged Acres = 0.00 Lost A = 0.00

Acres That Could Be Damaged by This Mini Flood

Crop	Initial	Replants	Lost Acres	Damaged Acres
Soybeans, Typical Management	840	0	0	0
Soybeans (Double Crop)	120	0	0	0
Wheat (Double Crop)	120	0	0	0
Corn for Grain, Typical Management	40	0	0	0

Parent Crop: Cotton, Typical Management
4,500 acres of cotton, typical management Moved to lost acres
Parent Crop, IRR cotton, typical management
500 acres of IRR cotton, typical management Moved to lost acres

Matrices of Flood after Applying This Band or Mini Flood

Crop	Operational Damages	Expected N R Damages	Replanted Acres	Lost Damaged Acres
Wheat (Double Crop)	2,111	5,683	0	120

Current Band Level is 1,000 acres

TABLE 2
A FLOOD BAND AFTER SEVERAL FLOODS HAVE ALREADY OCCURRED
DURING THE FLOOD YEAR

Julian Date	Digitized Stage Input Acres
181	2,400.0
182	2,400.0
183	2,400.0
184	2,400.0
185	2,400.0
186	2,500.0

End of Band Start: 181 End: 186 2,400.0 acres flooded

Yearly Matrices Prior to This Mini Flood

Crop	Operational Damages	Expected N R Damages	Replanted Acres	Lost Acres	Damaged Acres
Soybeans replant for corn	0.0	0.0	352.0	0.0	0.0
Soybeans (double crop)	0.0	20,307.0	0.0	0.0	0.0
Wheat (double crop)	4,419.0	12,503.0	0.0	264.0	0.0
Corn for grain, typical mgt	2,913.0	16,115.0	0.0	0.0	0.0

Acres left: 00 Starting ___ of mini flood: 181 Duration of mini flood: 6.0
Mini flood: Avg A = 2,400.0 replant A 352.0 damaged acres = .00 lost A = 264

Initial Acreage Distributions

Crop	Initial	Replants	Lost Acres	Damaged Acres
Initial (xinit) acreage = 2,016.0 initial (delta) = 56.00				
Soybeans, typical mgt	2,016.00	0.00	0.00	0.00
Soybeans replant for corn	0.00	352.00	0.00	0.00
Soybeans (double crop)	24.00	0.00	0.00	0.00
Wheat (double crop)	24.00	0.00	264.00	0.00
Corn for grain, typical mgt	8.00	0.00	0.00	0.00

Matrices or Flood After Applying This Band or Mini Flood

Crop	Operational Damages	Expected N R Damages	Replanted Acres	Lost Acres	Damaged Acres
Soybeans, typical mgt	116,605.0	259,721.0	0.0	2,016.0	0.0
Soybeans replant for corn	0.0	0.0	0.0	352.0	0.0
Soybeans (double crop)	565.0	1,846.0	0.0	24.0	0.0
Corn for grain, typical mgt	928.0	1,465.0	0.0	8.0	0.0

Current band level is 2,400.0 acres

TABLE 3
EXAMPLE REPORT FOR ONE FLOOD

Flood: 8

Starting Date	Ending Date	Net Acres Damaged	Peak Acres Flooded	Average Acres Flooded
06/30/77	07/05/77	2,400.00	2,500.00	2,500.00

Crops	Damages from Production Cost	Damages from Foregone Net Revenue	Total Damages	Net Damages/ Damaged Acre	Acres Replanted	Acres Lost	Acres Damages No Replant Needed
Soybeans, typical mgt	116,605.44	259,721.28	376,326.71	156.80	0.00	2,016.00	0.00
Soybeans replant for corn	0.00	0.00	0.00	0.00	0.00	352.00	0.00
Soybeans (double crop)	564.96	1,846.08	2,411.04	1.00	0.00	24.00	0.00
Corn for grain, typical mgt	927.92	1,464.96	2,392.88	1.00	0.00	8.00	0.00
Totals	118,058.32	263,032.31	381,130.63	185.80	0.00	2,400.00	0.00

TABLE 4
EXAMPLE FLOOD YEAR REPORT

End-of-Year Adjustments to Prod Costs, Revenues for Residual Replants
Crop Cost Revenue

Vicksburg Flood Damage Assessment Double, with Two Singles Run Date: 07/23/81
Crop Damage Summary for the Flood Year Ending on 12/31/77 Average Acres Flooded: 31,100.00

Crops	Damages from Production Cost	Damages from Foregone Net Revenue	Total Damages	Net Damages/ Damaged Acre	Acres Replanted	Acres Lost
Soybeans, typical mgt	128,370.48	281,364.71	409,735.19	142.47	0.00	2,184.00
Soybeans replant for corn	0.00	0.00	0.00	0.00	0.00	352.00
Soybeans (double crop)	1,379.76	23,999.04	25,378.80	8.82	0.00	48.00
Wheat (double crop)	9,273.48	25,574.40	34,847.88	12.12	0.00	276.00
Corn for grain, typical mgt	4,769.20	19,044.48	23,813.68	8.28	0.00	16.00
Totals	143,792.91	349,982.63	493,775.54	171.69	0.00	2,876.00

TABLE 5

EXAMPLE REACH REPORT

Starting Date	Ending Date	Net Acres Damaged	Peak Acres Flooded
01/03/77	12/31/77	2,876.00	2,700.00

Crops	Damages from Production Cost	Damages from Foregone Net Revenue	Total Damages	Net Damages/ Damaged Acre	Acres Replanted	Acres Lost	Acres Damages No Replant Needed
Soybeans, typical mgt	128,370.48	281,364.71	409,735.19	142.47	0.00	2,184.00	0.00
Soybeans replant for corn	0.00	0.00	0.00	0.00	0.00	352.00	0.00
Soybeans (double crop)	1,379.76	23,999.04	25,378.80	8.82	0.00	48.00	0.00
Wheat (double crop)	9,273.48	25,574.40	34,847.88	12.12	0.00	276.00	0.00
Corn for grain, typical mgt	4,769.20	19,044.48	23,813.68	8.28	0.00	16.00	0.00
Totals	143,792.91	349,982.63	493,775.54	171.69	0.00	2,876.00	0.00
Number of Years Reported	4						
Total and Annual Damages	493,775.54	123,443.88					
Net Annual Acres Damaged	719.00						
Average Annual Damages/Acre Damaged	171.69						
Total Banded Acres Flooded	31,100.00						
Damages/Banded in Flood Peaks	15.88						
Total Acreage in Flood Peaks	31,100.00						
Damages/Flood Peak Acre	15.88						

Net acres damaged annually by years by quarters for the reach (Based on quarters in which flooding occurred)

Quarter	Acres	Year
1	240.00	77.00
2	2,776.00	77.00
3	200.00	77.00
4	276.00	77.00

Maximum Net acres damaged annually by years by quarters for the reach (Based on quarters in which flooding occurred)

Quarter	Acres	Year
1	240.00	77.00
2	2,776.00	77.00
3	200.00	77.00
4	276.00	77.00

62. Damages were incurred on wheat (double crop) only because wheat was the only crop in place during January 3-12. Operational damages were $2,111. To calculate operational damages, we would add up costs and returns from the beginning of the crop until the date of the flood. In this case (see the wheat (double crop) flood damage table, under user's guide, part d), there were damages of 17.59 per acre (2,100 = 17.59 times 120). Also, there were Expected Net Revenue (ENR) losses of 5,683. The ENR losses are calculated by multiplying ENR values (see card type 3 under General Card Inputs in the user's guide) by acres. The ENR value for wheat in this example is 47.36 (5,683 = 47.36 times 120).

63. In debug mode, each band of inundation is enclosed within lines of asterisks for readability. Each flood will contain one or more (usually many) flood bands.

64. Crop-specific flood peaks (highest point at which damages occurred) are maintained throughout each flood year (January 1 – December 31 for spring crops and August 1 – July 31 for winter crops). Flood peaks are used to determine initially flooded and reflooded land. Reflooded land is prorated among replanted, lost, and damaged acres. It represents land that was lower than the highest previous flood peak. Initially flooded land (land higher than the previous flood peak) is determined by multiplying the initial distribution crop percentage by the total acres higher than the previous flood peak (current acres-flood peak acres) for each crop. If the current flood peak is higher than the previous flood peak and damages to the crop occurred, the current flood peak becomes the new flood peak until either a higher damage causing peak is detected or until the end of the flood year for the crop.

65. Table 2 illustrates how the land allocation algorithm operates after several floods have occurred. It is the first band of the eighth flood of the year, and several crops have incurred damages (see yearly matrices prior to this miniflood).

66. Now, look at initial distributions. Typical management soybeans had no previous damages, so the initial acreage was .84 times 2,400 = 2,016. Soybeans replant for corn had 352 acres because there was no previous flood peak set (this crop had received acreages from other crops, but had not directly incurred any damages—see Table 2. Soybeans (double crop) had a previous flood peak of 2,200 acres. Therefore, the acreage for soybeans (double crop) is (2,400-2,200) times .12 = 24 acres. Wheat (double crop) also had a previous flood peak of 2,200 acres. Also, it had 264 acres previously lost. Initial acres flooded was the same as soybeans (double crop). The total acreage that could be allocated to wheat (double crop) is 12 percent of the 2,400 acres in the miniflood or 288 acres. Since 24 acres are considered as initial acres (2,400-2,200 times .12 = 24), up to 264 acres can be allocated for lost and replanted acres combined. Since exactly 264 acres was left in wheat lost acres, it was all allocated. Eight acres (2,400-2,200 times .04 = 8) were allocated to corn for grain.

67. Damages (see parts c and d of example problem for ENR figures and flood damage tables) for Typical Management Soybeans are $116,605 [(7.65 + 3.03 + 3.03 + 13.99 + 1.67 + 1.67 + 2.93 + 23.87 = 57.84) 57.84 times 2,016 = 116,605] for operational damages, and $259,721 for ENR damages (Soybeans ENR, part (c) = 128.83, times 2,016 = 259,721).

68. No damages were assessed to Soybeans Replant for Corn because the flood began on day 181, which means (see (d), Soybeans Replant for Corn) that only the flood event for day 177 is added in and it had 0 cost. Since the Soybean Replant for Corn budget had no alternatives (part (c)), this acreage was lost.

69. Soybeans (double crop) had operational damages of $565 (23.54 times 24 = 565) and ENR damages of $1,846 (76.92 times 24 = 1,846). All 24 acres were lost because the alternative budget used. Soybeans Replant for Corn had a last date of planting of day 182, last flood day + dryout = 192.

70. Corn for Grain had operational damages of $928 [(9.7 + 1.94 + 4.55 + 4.42 + 1.35 + 13.86 + 1.46 + 26.02 + 2.21 + 18.53 + .65 + 19.01 + 9.63 + 2.66 = 115.99) times 8 = 928]. The ENR damages for corn were $1,465 (8 times 183.12 = 1,465). Corn acreages were all lost because the Soybeans Replant for Corn last date of planting is day 182, last flood day plus dryout of 10 days = day 192.

71. All flood of bands are processed in a similar manner.

72. When crops are replanted with an alternative crop, CACFDAS will lose the ENR associated with the initial crop when the initial crop is replanted. If the replant crop is in place at the end of the flood year for the crop, "sweepdown" end-of-year adjustments are done to recover all monies made by switching to the replant crop.

73. Table 3 is an example flood (flood 8) report. It contains the summation of all damages incurred by flood bands derived from each flood. Since all flood 8 damages incurred were in the band explained directly above, the damage totals for each crop are the same as for the first band. There was another flood band in the flood (see acreage for Julian date 186), but the 100 acres flooded were only flooded for 1 day, not long enough for damages.

74. Table 4 shows where end-of-year adjustments would be done (there were no replants in place at the end of the example flood history), and it gives the summary of all floods incurred during the flood year (1977 in this example).

75. Table 5 is a reach summary report for the example flood history (digitized stage input data) shown in the example problem (page 54). Although the history covered 4 years, there is flooding in 1977 only. Therefore, the damage totals are the same as for the 1977 flood year.

76. Some reach summary calculation methods are given below.

a. Number of years reported is read in on the reach header card.

b. Total damages are the summation of production cost and ENR damages.

c. Annual damages are total damages divided by number of years reported.

d. Net annual acres damaged is the total acres having damages divided by number of years reported.

e. Average annual damages/acre damaged is annual damages divided by annual acres damaged.

f. Total banded acres flooded is summation of all flood bands.

g. Damages per banded acre flooded is total damages divided by total banded acres flooded.

h. Total acreage in flood peaks is summation of peak acres flooded for all floods.

i. Damages per flood peak acre is total damages divided by total acreage in flood peaks.

77. Minimum and maximum acres damaged by quarters by flood years were computed by considering nonzero observations of acres flooded for each flood year by quarters.

FLOOD DAMAGE PROGRAM USER'S GUIDE

78. A general flow chart for CACFDAS is in Appendix A. There are three sets of data utilized by CACFDAS. They include (a) a file containing digitized stage input data for the reach to be processed (the program reads these data as file 8); (b) a file containing flood damage tables to be used to process the reach (the program reads these data as file 9); and (c) general card image inputs for the reach (the program reads these data through a logical card reader, device code 5). All fixed format integer data are right justified and blank or zero filled. Floating point data (data containing a decimal) can be placed anywhere in the field. Free formats are optionally allowed for flood damage table (card type 4) tabular inputs only. Free format data fields must be separated by commas.

Digitized Stage Input Data Form

79. This is assumed to be a sequential file (8) of the following format.

Card Columns	Description
1-6	Date. Month in 1-2, day in 3-4, year in 5-6.
11-20	Gage reading, decimal punched. These data are not used by this program and can be omitted, if desired.
33-40	Acres flooded. May be right justified integer, or decimal can be punched.

NOTE: Digitized stage inputs are assumed to be sorted by year (Major Control), month, day (Minor Control).

Flood Damage Tables

80. This file (9) is also a sequential file and should be of the following formats.

a. Format 1: Header card for crop. This card is the first image prior to tabular data for the crop.

Card Columns	Description
1	"4." This identifies the data as part of a flood damage table.
3-4	Crop Number. Should be a right justified integer between 1 and 40. See pages 11-12 for example crop definitions.
6-8	Zero or blank. Zeroes or blanks in these columns force this to be the first card of a particular crop when data is sorted.
10	"W" for winter crops only. Otherwise, blank.
12-47	Identification of the crop.

NOTE: This format is fixed, even when the free format option is used for format 2 inputs (see next format).

b. Format 2: Flood damage tabular data. When the free format option is used, all data fields shown for this format are entered in free form, separated by commas.

Card Columns	Description
1	"4." This identifies the data as part of a flood damage table.
3-4	Crop Number as described above.
6-8	Julian date for each cost/revenue flow associated with each crop activity (cultural practices, planting, harvesting, etc.). Right justified, blank filled integer. Fields 6-8 should contain positive integers between 1 and 365. These numbers should be in sequential order.
9-18	Cost associated with budget transactions. Should be stated in dollars and cents. May be right justified integer (dollars only) or floating point decimal punched.
19-28	Revenue percentage associated with budget transactions. Should be stated as a decimal fraction of 1, with decimal punched. The summation of all revenue percentages should always be 1 for a particular crop. Each percentage value is multiplied by crop-specific gross revenue totals to obtain gross revenue flows for each crop.
29-31	Critical durations are needed for all field events associated with initial crops from planting dates until the last harvest event. Critical durations are needed for all field events associated with replant crops. A zero critical duration (with the exception of pasture budgets and field events prior to planting for initial crops) value means no crop losses or damages.

NOTE: All crop flood information is assumed to be sorted in ascending sequence on card columns 1-8.

General Card Input Data

81. There are five possible card formats (a-e) that may be placed in general card input data. Except for the reach header (the first card), they may be in any order. The formats include (a) a reach header card; (b) crop percentages for the reach; (c) expected net and gross revenue values for each crop; (d) alternative crops information for initial crops that can be replanted; and (e) planting date (initial crops), last date of replanting (replant crops), and minimum operation date for initial crops. In typical situations, all card types are required. If replants are not allowed, card type 5 (alternative crops card) need not be coded. Card formats for the data described above are presented next.

a. Reach header card.

b.

Card Columns	Description
1	"1." Identifier for reach header.
3	Debug flag. "1" is debug mode, blank or zero is normal reporting mode (reports for each flood, each flood year, and the reach), and "2" is brief mode (yearly and reach reports only).
4	Free format flag. "1" if data inputs for flood damage tables are to be free form. Otherwise, fixed formats will be used for all inputs.
5	Overbooking flag. "1" if overbooking (defining more than 100 percent of the acreage in crops) is allowed. Otherwise, an error will result if more than 100 percent of the acreage is "booked."
6-7	Number of years covered by analysis (number of years of data).
8-9	Dryout period in days assumed for this analysis.
10-14	Percent of flooded acreage assumed partially damaged (pertinent only when the flood duration causes no damage to the crop). Decimal punched. Example: 0.10 is 10 percent.
16-71	Name of Reach.

NOTES: All variables for columns 1-9 are integers.
Card column 10-14 is a floating point.
Card column 16-71 is a character variable.

c. Reach percentage data for all crops grown in a particular reach.

(1) Up to 13 crop number - crop percentage combinations may be coded on each reach percentage card. A 2 should be coded in Column 1, followed by up to 13 crop number-crop percentage combinations coded as 6-digit fields.

(2) Crop numbers may be coded in any order. More than one crop percentage card may be coded. If needed, subsequent crop percentage cards should be coded in exactly the same format. When no double crops are present, crop percentages should not exceed 100 and will usually be less than 100 because of uncultivated acres. When double crops are defined, the acreage can be "overbooked" (see overbooking flag, reach header) to allow for double crops.

Card Columns	Description
1	Code a "2" to define this card as a reach percentages data card.
3-4	Crop number (see key to crop numbers, page 8) associated with the following percentage. Should be a right justified, space filled integer.
6-7	Percentage of the reach acreage grown in the crop associated with the preceding crop. Right justified, space filled integer.
9-10	Crop number associated with second crop.
12-13	Crop percentage associated with second crop.
15-16	Crop number associated with third crop.
18-19	Crop percentage associated with third crop.
21-25	Fourth crop (six digits are needed to describe each crop).
63-73	Twelfth crop.
74-79	Thirteenth crop.

d. Expected net revenue and gross revenue values for each crop.

Card Columns	Description
1	"3." Identification code.
3-4	Crop code (see key, page 8).
6-13	Expected net revenue associated with crop.
14-21	Expected gross revenue associated with crop.
22-80	Crop identification information is currently coded in these card columns.

e. Alternative crop control cards for initial crops.

Card Columns	Description
1	"5." Identifier.
3-4	Initial crop code (see key, page 8).
6-7	First alternative crop code.
9-10	Second alternative crop code (optional).

f. Control card for planting, last date of replanting, and minimum field operation dates.

Card Columns	Description
1	"6." Identifier.
3-4	Crop code.
6-8	Julian date which is the normal planting (initial crop) and last date of replanting (replants).
10-12	Minimum operations date for initial crops.

EXAMPLE PROBLEM

82. Examples of all data formats necessary to run CACFDAS are contained in this problem. Comments explaining individual data images are underlined. Data in this example were used to generate the reports shown in Tables 1-5.

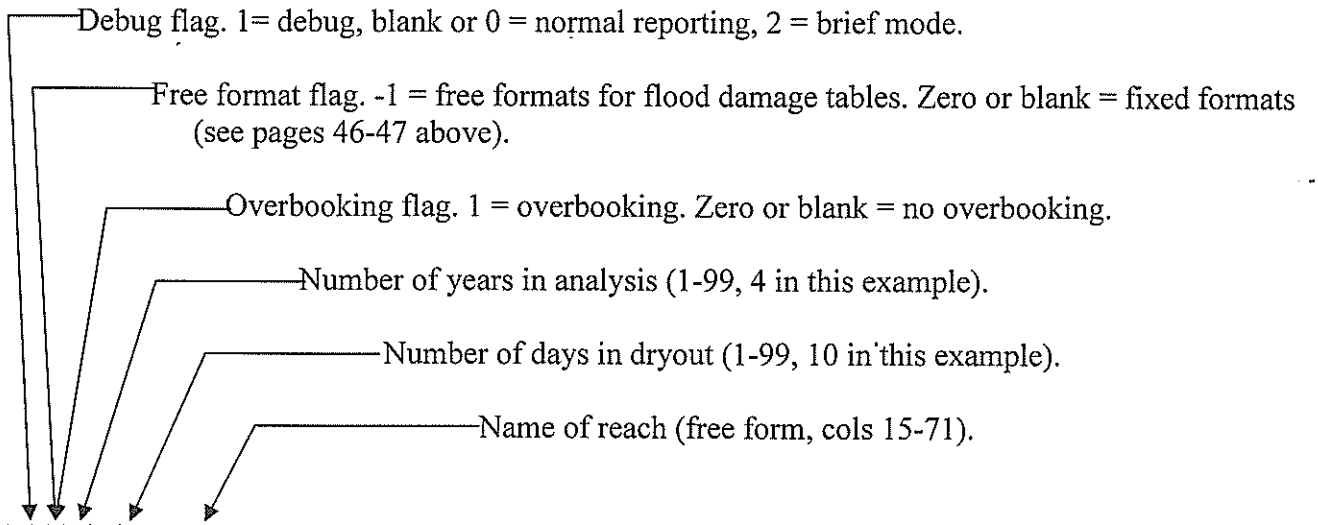
a. Control stream. The following control stream is for a UNIVAC 1100 system, but similar file setups would be necessary for any computer system.

@ASG, A FLOOD	
@ASG, A DSI	Digitized Stage Inputs (see b below).
@USE 8, DSI	Link DSI to logical device 8.
@ASG, A BGTS2	Flood Damage Tables (see d below).
@USE 9, BGTS2	Link to logical 9.
@HDG VICKSBURG FLOOD DAMAGE ASSESSMENT	
@XQT FLOOD.MAIN	Execute CACFDAS.
@ADD FLOOD.TESTALT	Generalized card inputs (see c below.)

b. Digitized stage input data. Column 1 is date of flood, columns 37-40 in this example are acres flooded (see page 49 above).

010377	1000
011277	1200
012377	1400
030377	1600
031277	1800
032877	2000
040477	1500
041477	1100
042977	1300
050377	1700
051977	1900
052977	2100
061077	2200
061577	2300
063077	2400
070577	2500
072077	2600
073077	2700
081077	1100
081777	1200
082577	1300
090577	1400
091877	1500
093077	1600
100677	1700
101577	1800
102577	1900
110977	2000
111677	2100
112677	2200
121077	2300
121977	2450
123177	2650

c. General card inputs. These images are needed as internal control to the CACFDAS program. The card type is coded in column 1, and the formats are explained in pages 47-50 above (see Figure 3).



1 111 410 TEST CASE	o	Reach header card
2 16 04 7 84 11 12 12 12	o	Crop percentages for the reach
3 7 128.83 213.16. ENR	o	Gross Revenues for crop 7, soybeans.
3 8 213.16	o	Gross Revenue for crop 8, soybeans replant for soybeans
3 9 213.16	o	Gross Revenue for crop 9, soybeans replant for corn
3 11 76.92 123.80	o	Soybeans for double crop
3 16 183.12 308.61	o	Corn for grain
3 12 47.36 81.41	o	Wheat for double crop
5 11 9	o	Replant soybeans DC with soybeans replant for corn.
5 16 9	o	Replant for corn for grain.
5 7 8	o	Replant soybeans with soybeans
6 7 177 160	o	Normal planting date for soybeans is day 177, min ops date is 160
6 16 146 130		
6 8 182	o	No minimum operations date for replants
6 9 182		
6 11 167 160		
6 12 309 305		

Figure 3. General Card Inputs

d. Flood damage tables. The BGTS2 file referenced in a above is shown below. Example flood damage tables from which such files can be created are shown in Appendix B. Computer formats for flood damage tables are given on pages 50-51. Computerized Flood Damage Table (free format).

```
4, 7   0  SOYBEANS, TYPICAL MGT
4,07,1,7.65,0,0
4,07,165,3.03,0,0
4,07,167,3.03,0,0
4,07,169,13.99,0,0
4,07,171,1.67,0,0
4,07,173,1.67,0,0
4,07,175,2.93,0,0
4,07,177,23.87,0,3
4,07,182,7.86,0,2
4,7,183,2.66,0,4
4,7,197,1.67,0,4
4,7,212,10.07,0,4
4,7,223,3.93,0,4
4,7,279,.3,1.,4

4 16   0  CORN FOR GRAIN, TYPICAL MGT
4,16,1,9.7,0,0
4,16,134,1.94,0,0
4,16,135,4.55,0,0
4,16,137,4.42,0,0
4,16,139,1.35,0,0
4,16,140,13.86,0,0
4,16,141,1.46,0,0
4,16,143,26.02,0,0
4,16,145,2.21,0,0
4,16,146,18.53,0,4
4,16,146, .65,0,4
4,16,153,19.01,0,4
4,16,172,9.63,0,6
4,16,172,2.66,0,6
4,16,289,9.5,1.,10
```

4 8 0 SOYBEANS REPLANT FOR SOYBEANS
4,8,177,0,0,0
4,8,182,23.87,0,3
4,8,187,7.86,0,2
4,8,188,2.66,0,4
4,8,197,1.67,0,4
4,8,212,10.07,0,4
4,8,223,3.93,0,4
4,8,279,.3,1.,4

4 9 0 SOYBEANS REPLANT FOR CORN
4,9,177,0,0,0
4,9,182,26.8,0,3
4,9,187,7.86,0,2
4,9,188,2.66,0,4
4,9,197,1.67,0,4
4,9,212,10.07,0,4
4,9,223,3.93,0,4
4,9,279,.3,1.,4

4 11 0 SOYBEANS (DOUBLE CROP)
4,11,167,23.54,0,4
4,11,184,5.25,0,2
4,11,186,3.1,0,6
4,11,198,2.06,0,6
4,11,212,4.09,0,6
4,11,221,3.56,0,6
4,11,289,2.11,.4,5
4,11,294,2.11,.4,5
4,11,308,1.06,.2,5

4 12 0 W WHEAT (DOUBLE CROP)
4,12,1,17.59,0,6
4,12,46,11.12,0,2
4,12,158,5.31,1.,3
4,12,165, .03,0,0
4,12,309,17.59,0,6
4,12,365,0,0,0