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Computer Program Directory for Petroleum Assessment of Wilderness Lands in the Western United States

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards. The content of computer programs, although extensively field-tested, cannot be warranted as to correctness or suitability for a particular use.

1. U.S. Geological Survey, Denver, Colorado

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Introduction

This Open-File Report describes the function and operation of a series of computer programs intended to aggregate the data on estimates of the oil or gas resource potential in a group of geologic units (basins, provinces, or clusters) and to produce a more-than cumulative probability distribution curve on a computer graphical plotting device.

The software products described here are based on the methodology contained in U. S. Geological Survey Circular 902-A-P (Crovelli, 1983). The software was used to generate the resource estimates and probability curves for the petroleum assessment of wilderness lands in the western United States.

This document is not intended to be either a reference or user's manual for these programs; it is only a directory to the software products used to generate the estimates which appear in Circular 902. The intended audience for both this document and the computer programs described herein are geologists or other professionals engaged in oil or gas resource appraisal. No computer background is assumed.

Terminology

The general statistical and probabilistic terminology used in this series of software is described fully in a previous Open-File Report (Crovelli, 1981).

Environment

The programs and subroutines described in this report are all written in Fortran for the Digital VAX 11/750 computer running the VMS operating system, version 3.0. The control structures used are strictly at the level of Fortran IV. However there are some data structures and special functions used which are unique to the VAX Fortran compiler. These non-standard features are documented fully in the source programs for the aid of those who may want to transport them to another machine.

All the program modules described below are stand-alone programs except for DISSPLA1 and DISSPLA2, which are subroutines referred to by the other programs. Subroutines DISSPLA1 and DISSPLA2 form the graphics-producing core of this series. LOGNORM3 calls on DISSPLA1, while LOGNORM3b and LOGNORM3p call DISSPLA2. These two subroutines both assume the availability of the TELL-A-GRAF computer graphics software. TELL-A-GRAF is a registered trademark of Integrated Software Systems Corporation (ISSCO).

Subroutines DISSPLA1 and DISSPLA2, as well as programs EXACTDIS, LOGNORM3, LOGNORM3p, and LOGNORM3b all require the use of a line-plotting device such as a

standard graphics terminal or x-y plotter. Any plotting device supported by the ISSCO TELL-A-GRAF device drivers can be used.

The remaining support programs (VERIFIER, PRODLOGN, CULL, PRODLOGNp) require no special hardware or software facilities.

Pipelines

This is a system of inter-related programs, each designed to accomplish a part of the total resource appraisal task. There are several "pipelines", or lines of communication, between them. A permanent file is the mechanism for passing information from one program to the next. Thus a raw data file is given to program VERIFIER, which checks the data for syntax errors and helps to guarantee the integrity of the assessment process. A verified raw data file is then passed into program PRODLOGN, which converts the data into a lognormal distribution. The output of PRODLOGN is then turned over to program LOGNORM3, which aggregates the lognormal moments in the PRODLOGN output, and prepares a file of plot parameters in a form acceptable to the ISSCO TELL-A-GRAF graph-plotting utility. This sequence of programs and intermediate data files is a pipeline. The invocation of each program in the pipeline is done manually; one program does not automatically execute its successor.

Abstracts

An abstract of each program in the series is shown on the following pages, in pipeline order.

VERIFIER

Abstract

This program helps to validate the data entered into files for processing by the program PRODLOGN. VERIFIER reads and analyzes files of geologist's raw data to see if the entries are syntactically correct for passing into program PRODLOGN for generating a lognormal distribution. If errors are found in the source file, diagnostics are printed on the listing file VERIFIER.OUT.

Input

The input is on an ASCII file, prepared by the use of a text editor. The name of this input file is requested interactively by the program. The data file contains one header line giving the resource type (one of the words "oil" or "gas", in lower case as shown), one blank space, and the full State name where the resource lies. This header line is followed by a variable number of detail lines, each containing 9 numbers:

N_CLUSTER, PA_B, FA, RMIN, RMAX, N_PROVINCE, PB, CX95, CX05

The numbers can be separated by blank spaces or commas. The inputs are defined as follows:

N_CLUSTER = cluster number (integer)
PA_B = conditional probability of resource in cluster, given resource in basin (real)
FA = area fraction; fraction of basin covered by cluster (real)
RMIN = lowest rating, or richness factor (real)
RMAX = highest rating, or richness factor (real)
N_PROVINCE = geologic province number (integer)
PB = probability of resource in basin (real)
CX95 = low resource estimate, or 95th fractile: 95% probability of more than this amount of resource in cluster (real)
CX05 = high resource estimate, or 5th fractile: 5% probability of more than this amount of resource in cluster (real)

Output

VERIFIER produces a summary listing on a permanent file named VERIFIER.OUT. It shows a verbatim copy of the input file, and a formatted tabular listing of its content for ease of visual checking of entries. It includes error diagnostics, if syntax errors were found in the input.

Related Programs

Properly verified data files are then ready to be processed through program PRODLOGN (following) to yield a lognormal distribution. PRODLOGN is run separately - VERIFIER does not execute PRODLOGN automatically.

PRODLOGN

Abstract

Program PRODLOGN accepts as input a file of parameters on estimates of oil and gas resources in clusters within resource appraisal units (States or basins) and converts the data into a lognormal distribution appropriate for passing to the aggregation program LOGNORM3.

Input

The data file (whose name is requested interactively by PRODLOGN) consists of raw data for all the clusters in one State. The data is arranged as follows:

line 1: The resource name (oil or gas), one blank space, and the full State name.

Other lines: There must be one line for each cluster in the state, each line containing the following 9 numbers:

N_CLUSTER, PA_B, FA, RMIN, RMAX, N_PROVINCE, PB, CX95, CX05

The numbers can be separated by blank spaces or commas. The inputs have the following meanings:

N_CLUSTER : cluster number (integer)
PA_B : conditional probability of resource in cluster, given existence of the resource in basin (real)
FA : area fraction; fraction of province area covered by current cluster (real)
RMIN : cluster low rating (or richness) factor; ratio of resource potential in cluster to resource potential in whole province (real)
RMAX : cluster high rating (or richness) factor; ratio of resource potential in cluster to resource potential in whole province (real)
N_PROVINCE : province number (integer)
PB : probability of resource in basin (real)
CX95 : low resource estimate, or 95th fractile; 95% probability of more than this amount of resource in cluster (real)
CX05 : high resource estimate, or 5th fractile; 5% probability of more than this amount of resource in cluster (real)

Output

The program produces two output files, both of which are generated, saved, and named automatically. The names are generated by appending the suffixes ".PL" and ".PLL" to the raw-data file name given to the program. These files are saved on the system disk, to be printed as a separate operation by the user.

<raw-data>.PL : This file contains the result output in lognormal parameters, in a format suitable for passing directly to the plotting program LOGNORM3.

<raw-data>.PLL : This file contains a written summary of the program's results in a format suitable for listing on a terminal or line printer.

Related Programs

The input to PRODLOGN is a file of data which should have been verified by program VERIFIER (preceding). The output file of PRODLOGN is ready to be passed into program LOGNORM3 (following). LOGNORM3 is run by the user as a separate operation.

LOGNORM3

Abstract

This program aggregates moments of oil/gas resource estimates in geologic clusters of a State. It accepts as its input the first three moments of the lognormal distribution for oil or gas resources in a number of components (regions, clusters), aggregates the moments, and produces a cumulative probability distribution curve of the aggregate.

Inputs

The input resides on a permanent file, whose name is requested interactively by the program. Usually the input file will be the output of program PRODLOGN (preceding). The input file must have a name with the suffix '.PL' and it has the following structure:

line 1: The number of components, the number 5000, and the oil/gas code number; these are all integers, and are separated by at least one blank space. The oil/gas code is 0 (zero) for oil and 1 (one) for gas. (The 5000 is a dummy parameter, not used by this program. It is included for compatibility with a related program not in this series.)

line 2: the main title to appear on the plotted graph. This is a string of 60 or fewer characters.

other lines: One line for each component, each line containing 8 numbers. The only entries on the line which are used by LOGNORM3 are:

Entry #1, the cluster number (integer);
Entry #5, the marginal probability (real);
Entry #7, 1st parameter of the conditional distribution (real);
Entry #8, 2nd parameter of the conditional distribution (real).

The other entries are ignored by LOGNORM3. They are used by a related program not in this series. The adjacent numbers on these lines are separated by blank spaces.

LOGNORM3 can aggregate components using either the independent assumption or the perfectly positively correlated assumption, and the program asks the user to select the assumption interactively.

Outputs

Two kinds of output are produced:

1. A printed summary listing which is written on a permanent file. The program prints the name of this summary file at the terminal when the program runs. This name consists of the front part of the input file name, and the suffix '.L3L'.

2. A plotted graph of the aggregated probability distribution.

Related Programs

The input of LOGNORM3 should be taken from the output of PRODLOGN (preceding). LOGNORM3 makes use of subroutine DISSPLA1 (following) to format plotted output.

DISSPLA1

Abstract

This subroutine takes a set of arguments from the caller and uses them to write a file of commands to ISSCO's TELL-A-GRAF utility for formatting a more-than cumulative probability distribution plot for appraisal of oil or gas resources.

The differences between DISSPLA1 and DISSPLA2 (following) are:

1. DISSPLA1 writes a one-line main title at the top of the plotted graph; and this title is passed into DISSPLA1 through one of the calling parameters. (DISSPLA2 writes a two-line title through a COMMON block.)

2. DISSPLA1 produces an unconditional plot; and, if the marginal probability is less than 1, it produces an additional combined conditional/unconditional plot. (DISSPLA2 produces only the conditional plot.)

Facilities

Use of this subroutine assumes you have available the ISSCO TELL-A-GRAF plotting software and any graphics plotting device supported by the TELL-A-GRAF device drivers.

```
SYNTAX:  call DISSPLA1 (      PROG,      TITL,     XSCALX,
                                 A,        YP,      ITYPE,
                             UMEAN,   UMEDIAN,       UF95,
                              UF75,      UF50,       UF25,
                              UF05,     UMODE,        USD,
                             PMARG,  CONDMEAN, CONDMEDIAN,
                              CF95,      CF75,       CF50,
                              CF25,      CF05,   CONDMODE,
                            CONDSD)
```

The arguments are described below:

A : Array of 70 x-coordinates on the curve to be plotted (real)
CF05 : Conditional 5th fractile (real)
CF25 : Conditional 25th fractile (real)
CF50 : Conditional 50th fractile (real)
CF75 : Conditional 75th fractile (real)
CF95 : Conditional 95th fractile (real)
CONDMEAN : Conditional mean (real)
CONDMODE : Conditional mode (real)
CONDMEDIAN : Conditional median (real)
CONDSD : Conditional standard deviation (real)
ITYPE : Resource type (integer): 0 for oil, 1 for gas.
PMARG : Marginal probability (real)
PROG : The name of the calling program (9 characters)
TITL : Main title of the plot (60 characters, mixed case OK)
UF05 : Unconditional 5th fractile (real)
UF25 : Unconditional 25th fractile (real)

UF50 : Unconditional 50th fractile (real)
UF75 : Unconditional 75th fractile (real)
UF95 : Unconditional 95th fractile (real)
UMEAN : Unconditional mean (real)
UMEDIAN : Unconditional median (real)
UMODE : Unconditional mode (real)
USD : Unconditional standard deviation (real)
XSCALX : No longer used; preserved for compatibility with an earlier program.
YP : Array of 70 y-coordinates for the curve to be plotted (real)

Output

The subroutine produces a file named TAGINPUT.DAT which contains commands telling the TELL-A-GRAF plotting utility how to format a graph. TELL-A-GRAF is invoked as a separate operation, and is given the name of the TAGINPUT.DAT file interactively. This process produces an unconditional probability distribution curve; and if the marginal probability PMARG is < 1, it further produces a combined conditional/unconditional plot.

Related Programs

See the discussion of DISSPLA2 (following)

CULL

Abstract

CULL takes a concatenated file of all the raw-data files assembled for the appraisal of oil/gas resources in a region, and culls the concatenated file by province number: it makes up a separate file of collected data for each geologic province appearing in the concatenated data.

Inputs

All required data input resides on a permanent ASCII file whose name is requested interactively by the program. This file is prepared in advance using a text editor. The data file has the following structure:

Line 1: The resource name ("oil" or "gas"), one blank space, and the "group name"; for example:

oil Western United States

This information begins in column 1 of the line.

Other lines: any number of detail lines, each representing one geologic cluster. Each line contains the following 9 numbers:

N_CLUSTER, PA_B, FA, RMIN, RMAX, N_PROVINCE, PB, CX95, CX05

They can be separated on the data file by commas or blank spaces. The inputs are defined as follows:

N_CLUSTER : geologic cluster number (integer)
PA_B : conditional probability of existence of resource in cluster, given existence of resource in province (real)
FA : area fraction; fraction of the basin which is covered by the cluster (real)
RMIN : cluster low rating (or richness factor); ratio of resource potential in cluster to resource potential in province (real)
RMAX : cluster high rating (or richness factor); ratio of resource potential in cluster to resource potential in province (real)
N_PROVINCE : geologic province number (integer in the range 1 .. 141) [Province numbers used in original data are 1 .. 136 plus the extra numbers 81a, 901, 902, 84a, and 84b. These last five province numbers are represented in the BULK_DATA file by 137, 138, 139, 140, and 141 in order to get province numbers in a contiguous interval. This program changes the five back to 81a, 901, 902, 84a, 84b before writing out the files.]
PB : probability of resource in basin (real)
CX95 : estimated minimum amount of resource in cluster, with 0.95 probability, conditional on existence of resource in province (real)
CX05 : estimated minimum amount of resource in cluster, with 0.05 probability, conditional on existence of resource in province (real)

The program also needs a list of names of geologic provinces, which it reads from an external file named PROVNAME.DAT. This file contains one province name per line, starting in column 1. The province names were taken from Circular 860 (Dolton and others, 1981).

Outputs

The program generates a variable number of output files, depending on the number of distinct province numbers which appear in the input. The output files are all generated and named automatically. There will be one output file for each distinct province number, and these will have names like OILPROV.81 or GASPROV.107, depending on the province number concerned and whether the resource is oil or gas. Each of these files can be passed directly into program PRODLOGNp to generate a lognormal distribution.

CULL also publishes a summary listing file whose name is <raw-data>.CL, where <raw-data> is the primary file name which CULL reads as its input.

Related Programs

The output files generated by CULL are then ready to be processed through the lognormal generating program PRODLOGNp (following). PRODLOGNp is run as a separate operation; CULL does not execute PRODLOGNp automatically.

PRODLOGNp

Abstract

Program PRODLOGNp accepts as input a file of parameters on estimates of oil and gas resources in clusters within geologic provinces and converts the data into a lognormal distribution appropriate for passing to the aggregation program LOGNORM3p. The input to PRODLOGNp is normally the output of CULL (preceding).

PRODLOGNp is a variation of PRODLOGN. PRODLOGNp is designed to handle data grouped by province, while PRODLOGN takes data grouped by State.

Input

The data file (whose name is requested interactively by PRODLOGNp) consists of raw data for all the clusters in one province. The data is arranged as follows:

line 1: The resource name (oil or gas), one blank space, and the province identifier (in the form Province xxx).

line 2: Full province name (80 characters).

Other lines: There must be one line for each cluster in the province, each line containing the following 9 numbers:

N_CLUSTER, PA_B, FA, RMIN, RMAX, N_PROVINCE, PB, CX95, CX05

These parameters are described below:

N_CLUSTER : cluster number (integer)
PA_B : conditional probability of resource in cluster, given the existence of the resource in basin (real)
FA : area fraction; fraction of province area covered by current cluster (real)
RMIN : cluster low rating (or richness) factor; ratio of resource potential in cluster to resource potential in whole province (real)
RMAX : cluster high rating (or richness) factor; ratio of resource potential in cluster to resource potential in whole province (real)
N_PROVINCE : sequential province number (integer)
PB : probability of resource in basin (real)
CX95 : low resource estimate, or 95th fractile; 95% probability of more than this amount of resource in province (real)
CX05 : high resource estimate, or 5th fractile; 5% probability of more than this amount of resource in province (real)

Output

The program produces two output files, both of which are generated, saved, and named automatically. The names are generated by appending the suffixes ".PL" and ".PLL" to the raw-data file name given to the program.

<raw-data>.PL : This file contains the result output in lognormal parameters, in a format suitable for passing directly to the plotting program LOGNORM3p.

<raw-data>.PLL : This file contains a written summary of the program's results in a format suitable for listing on a terminal or line printer.

Related Programs

Output files from PRODLOGNp are then ready to be processed through program LOGNORM3p (following) for aggregation and graphical output. LOGNORM3p is run as a separate operation; it is not called automatically by PRODLOGNp.

LOGNORM3p

Abstract

This program accepts as input the first 3 moments of the lognormal distribution for oil or gas resources in a number of components in one geologic province, aggregates the moments, and produces a cumulative probability distribution curve of the aggregate.

LOGNORM3p is a variation of LOGNORM3. LOGNORM3p aggregates estimates grouped by province, while LOGNORM3 aggregates estimates grouped by State.

Inputs

The input resides on a permanent file, whose name is requested interactively by the program. Usually the input file will be the output of program PRODLOGNp. The input file must have a name with the suffix '.PL' and it has the following structure:

line 1: The number of components, the number 5000, and the oil/gas code number; these are all integers, and are separated by at least one blank space. The oil/gas code is 0 (zero) for oil and 1 (one) for gas. (The 5000 is a dummy parameter, not used by this program. It is included for compatibility with a related program not in this series.)

line 2: the main title to appear on the plotted graph. This is a string of 60 or fewer characters.

line 3: Full name of the province (80 characters)

other lines: One line for each component, each line containing 8 numbers. The only entries on the line which are used by LOGNORM3p are:

Entry #1, the cluster number (integer);
Entry #5, the marginal probability (real);
Entry #7, 1st parameter of the conditional distribution (real);
Entry #8, 2nd parameter of the conditional distribution (real).

The other entries are ignored by LOGNORM3p. They are used by a related program not in this series. The adjacent numbers on these lines are separated by blank

spaces.

LOGNORM3p can aggregate components using either the independent assumption or the perfectly positively correlated assumption, and the program asks the user to select the assumption interactively.

Outputs

Two kinds of output are produced:

1. A printed summary listing which is written on a permanent file. The program prints the name of this summary file at the terminal when the program runs. This name consists of the front part of the input file name, and the suffix '.3PL'. Sending the file to a printer is a separate user operation.

2. A file containing information (in ISSCO TELL-A-GRAF language) for plotting a graph of the aggregated probability distribution.

Related Programs

The input to LOGNORM3p is the output file of PRODLOGNp (preceding). LOGNORM3p makes use of subroutine DISSPLA2 (following) to format plotted output.

LOGNORM3b

Abstract

This program accepts as input the first 3 moments of the lognormal distribution for oil or gas resources in a number of components (regions, clusters), aggregates the moments, and produces a cumulative probability distribution curve of the aggregate.

LOGNORM3b assumes units of billions of barrels (for oil) and trillions of cubic feet (for gas).

Inputs

The input resides on a permanent file, whose name is requested interactively by the program. The input file has the following structure:

line 1: number of components and the oil/gas code number. These are both integers, and are separated by at least one blank space. The oil/gas code is 0 (zero) for oil and 1 (one) for gas.

line 2: the main title to appear on the plotted graph. This is a string of 60 or fewer characters.

line 3: The assessment date, a string of 20 or fewer characters.

other lines: One line for each component, each line containing three real numbers (the first 3 moments of the lognormal resource distribution). The adjacent numbers on these lines are separated by blank spaces.

Outputs

Two kinds of output are produced. The units are BILLION barrels (for oil) and TRILLION cubic feet (for gas):

1. A printed summary listing which is written on a permanent file. The program prints the name of this summary file at the terminal when the program runs. Sending this file to a printer is a separate user operation.

2. A file of information (in ISSCO TELL-A-GRAF language) for generating a plotted graph of the aggregated probability distribution.

Related Programs

LOGNORM3b makes use of subroutine DISSPLA2 (following) to format plotted output.

DISSPLA2

Abstract

This subroutine takes a set of arguments from the caller and uses them to write a file of commands to ISSCO's TELL-A-GRAF utility for formatting a more-than cumulative probability distribution plot for appraisal of oil and gas resources.
The differences between DISSPLA2 and DISSPLA1 are:

1. DISSPLA2 plots a two-line title at the top of the graph, and this information is passed into the subroutine through a COMMON block. (DISSPLA1 plots a single title line.)

2. DISSPLA2 plots only an unconditional graph. (DISSPLA1 produces both an unconditional and a combined conditional/unconditional plot.)

Facilities

Use of the subroutine assumes you have available the ISSCO TELL-A-GRAF plotting software and any graphics plotting device supported by the TELL-A-GRAF device drivers.

```
SYNTAX:  call DISSPLA2 (      PROG,      TITL,     XSCALX,
                                 A,        YP,      ITYPE,
                             UMEAN,   UMEDIAN,       UF95,
                              UF75,      UF50,       UF25,
                              UF05,     UMODE,        USD,
                             PMARG,  CONDMEAN, CONDMEDIAN,
                              CF95,      CF75,       CF50,
                              CF25,      CF05,   CONDMODE,
                            CONDSD)
```

The arguments are described below:

A : Array of 70 x-coordinates on the curve to be plotted (real)
CF05 : Conditional 5th fractile (real)
CF25 : Conditional 25th fractile (real)
CF50 : Conditional 50th fractile (real)
CF75 : Conditional 75th fractile (real)
CF95 : Conditional 95th fractile (real)
CONDMEAN : Conditional mean (real)
CONDMODE : Conditional mode (real)
CONDMEDIAN : Conditional median (real)
CONDSD : Conditional standard deviation (real)
ITYPE : Resource type (integer): 0 for oil, 1 for gas.
PMARG : Marginal probability (real)
PROG : The name of the calling program (9 characters)
TITL : Not used by DISSPLA2; retained for compatibility with DISSPLA1.
UF05 : Unconditional 5th fractile (real)
UF25 : Unconditional 25th fractile (real)
UF50 : Unconditional 50th fractile (real)
UF75 : Unconditional 75th fractile (real)
UF95 : Unconditional 95th fractile (real)
UMEAN : Unconditional mean (real)
UMEDIAN : Unconditional median (real)
UMODE : Unconditional mode (real)
USD : Unconditional standard deviation (real)
XSCALX : Not used. This parameter survives to preserve compatibility with an earlier version.
YP : Array of 70 y-coordinates for the curve to be plotted (real)

Output

The subroutine produces a file named TAGINPUT.DAT which contains commands telling the TELL-A-GRAF plotting utility how to format a graph. TELL-A-GRAF is run as a separate operation, and is given the name of the TAGINPUT.DAT file interactively. This process produces an unconditional probability distribution curve.

Related Programs

See the description of DISSPLA1 (preceding).

Selected References

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