FAP24

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Water Resources Planning Organization

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Delft Hydraulics

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RIVER SURVEY PROJECT

Special Report No.21

Guide to RSP databases

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Guide to RSP Databases

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Acronyms and abbreviations

ADCP	: Acoustic Doppler current profiler
BIWTA	: Bangladesh Inland Water Transport Authority
BWDB	: Bangladesh Water Development Board
CSV	: Comma-separated values (a way of preparing a data file)
DHA	: (name of an RSP survey vessel)
DOS	: Disk Operating System (name of a computer operating system)
EMF	: Electromagnetic flow meter (= current meter)
EOL	: End of line
EOT	: End of transect
FAP	: Flood Action Plan
FAP24	: FAP project no. 24 (= the RSP)
LAN	: Local Area Network
MEX	: (Brand name of a turbidity meter)
PWD	: Public Works Department (and name of a datum)
PSD24	: Processed Survey Data of FAP24 (name of a FAP24 database)
RSP	: The River Survey Project (= FAP24)
SLW	: Standard Low Water (a datum used by BIWTA and others)
SOL	: Start of line
SOT	: Start of transect
SWMC	: Surface Water Modelling Centre
S4	: (Brand name of an EMF)
USBM54	: (Brand name of a bed material sampler)
WARPO	: Water Resources Planning Organization
WMO	: World Meteorological Organization
2-D	: 2-dimensional

1 Introduction

Extensive sets of data have been collected in the surveys of FAP24. After a series of analyses, processing and quality checks the data is ready for use, internally by the FAP24 study team or by external users. Most of the data are stored in electronic databases for easy access and further analysis. The data obtained in each survey is summarized in hard copy Survey Bulletins and again by station in Data Books.

The present report is primarily intended as an introduction to the FAP24 data, giving an overview of the data that can be found in the databases and data publications. It will hopefully be useful also as a User's Guide for external users to the electronic databases.

The basic categories of data are:

- flow data
- sediment data (including sediment transport data)
- bathymetry data

The data are collected in three types of surveys (unrelated to the above three categories of data):

- routine surveys (more or less pre-defined surveys at fixed locations)
- special surveys (defined by the FAP24 study team for the use in their studies)
- bathymetric surveys (more or less pre-defined surveys of fixed areas)

2 The databases, their use, and their users

2.1 Organisation of data storage

There are three RSP databases:

- PSD24 (= Processed Survey Data of FAP24): Results of the routine gauging and special surveys of flow and sediment transport
- HYMOS: Water level data
- Primary sediment analysis data

The data files of all three databases are catalogued in the RSP Data Books.

The bathymetry files are catalogued within PSD24, but the data files are not included in the database, because their number is limited, their size is big, and their processing is done in the UNIX environment. They can, however, be downloaded from the data tapes as finite grid arrays in ASCII format.

Most of the present report deals with PSD24, because its datafiles are much more complex than those of the other two databases.

2.2 The anticipated use of the databases

In the course of the Project, the databases have been used in general for the various activities within the Project's study component. These activities have aimed at general and specific analyses of hydrological and sediment transport processes and morphological developments.

After completion of the project, the data stored in the databases may potentially serve a variety of purposes within national river planning, administration and engineering, as undertaken by WARPO, BWDB, and other national agencies. Also, the data may be useful for future FAP projects and other projects that require river data.

Also, it is believed that the data will be of interest for many scientific purposes.

2.3 The anticipated user of the databases

It has been assumed that the data user is familiar with the QuattroPro spreadsheet, as a large majority of the processed data files are formatted for this system. Of course, it is possible to convert the files to any other format, if so preferred. The spreadsheet is conveniently applied in a DOS/Windows environment.

Some basic knowledge about accessing the Paradox catalogue system is also required.

The operator of PSD24 must be familiar with the UNIX environment, since some basic data file conversion operations are done in this operating system. Also, the operator must be well familiar with the Paradox system, which is used for the catalogue component of this database.

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2.4 The documentation of the databases

The databases and their contents are described at different levels of detail and complexity. Due to their self-explanatory nature, some users will not need any documentation at all for retrieval of data for the purpose of routine analyses.

Most users of data from the RSP routine flow and sediment transport gauging programme will, however, prefer to consult the *RSP Data Books* for a catalogue listing and for a description of the hydraulic regime of each gauging. For a description of the origin of the data, reference is made to *RSP Final Report Annex 1: Surveys*.

The procedures applied for data transformation are described in the present *RSP Survey Report 12: 'Guide to RSP Databases'*, which also provides the user with a basic introduction to the databases, which may be adequate for many purposes.

The general use of the *QuattroPro* spreadsheet and of the *Mike21 Pre- and Postprocessing software package* is described in *User's Guides*. For updating the PSD24 database, or for adding new data entries, additional documentation is required. This information is given in the *FAP24 off-line data processing manual*. Also, for this purpose, knowledge of the Paradox system is necessary. This knowledge can be obtained from the *Paradox Manual*.

The HYMOS system is menu-driven and is quite easily accessible. A description of its use and its data processing facilities is given in the *HYMOS Manual*.

The sediment database is entirely accommodated within a QuattroPro spreadsheet.

3 The PSD24 database

3.1 Introduction

Most of the Processed Survey Data of FAP24 are stored in a DOS/Windows based file system, PSD24. This database includes two main components: The first component is the processed data files. The second component is a catalogue system, listing all the files and file specific information for quick file identification and query searches.

The PSD24 files are created by processing of the raw data files on either UNIX or DOS computers, and then copied to the PSD24 Server which is accessible to the internal FAP24 Study Group via an Ethernet LAN (Local Area Network). The files are DOS formatted with the exception of the MIKE 21 bathymetry and iso-velocity files. The PSD24 files residing on the PSD24 Server are considered to be master copies and are 'read-only' accessible. The file catalogue system for the DOS based PSD24 is kept on Paradox 4.5 for Windows. The Paradox based catalogue lists the vital file specifics for each data file within the PSD24 and allows the user to perform a search for any file that meets the user specified criteria.

Data categories and file types

PSD24 contains the processed data files produced from the field surveys. There are two basic data file categories (a and b below), each category containing the following file types:

File contents		File format	File extension
a)	Routine transect survey data and study survey data (all other than bathymetric survey data)		
1)	ADCP/S4/EMF transect data	QPRO	.ase
2)	echosounder transect data	QPRO	.ech
3)	sediment transport data	QPRO	.sed
4)	longitudinal profile data	QPRO	.lng
5)	stationary velocity profile data	QPRO	.prf
6)	suspended sediment concentrations	QPRO	.ssc
7)	suspended sediment size	QPRO	.ssz
8)	bed load transport analyses	QPRO	.bdl
9)	bed material analyses	QPRO	.bdm
10)	flow and sediment transport distribution	QPRO	.trs
11)	iso-velocity plot data	MIKE 21	.dt2 and .ct2
b)	Bathymetric survey data		
1)	fixed grid bathymetry data	MIKE 21	.dt2 and .ct2

3.2 File name conventions and directory structure

File names for the transect survey data retain the same name structure as the raw data except that the extension will be used to identify the different types of PSD24 files.

Example file name: *b2al1t08.ech*

b	*= Survey location*
2	*= 1992 (year)*
a	*= 10 or October (month)*
l	*= 21 (day)*
1	*= Vessel No. 1*
t	*= Transect (B = bathymetry)*
08	*= Sequence no.*

Survey location	Code
Aricha	*a*
Bahadurabad	*b*
Baruria	*u*
Bhairab-Bazar	*z*
BWDB	*v*
Hardinge Bridge	*h*
Kushtia	*k*
Mawa	*m*
Mymensingh	*y*
Offtake Arial Khan	*o*
Sirajganj	*s*
SWMC	*w*
Tilly	*t*

File extension/ File type	
.ase	*ADCP/S4/EMF transect data (QPRO)*
.ech	*echosounder transect data (QPRO)*
.sed	*sediment transport data (QPRO)*
.lng	*longitudinal profile data (QPRO)*
.prf	*stationary profile data (QPRO)*
.ssc	*suspended sediment concentration analysis (QPRO)*
.ssz	*suspended sediment size analysis (QPRO)*
.bdl	*bed load sediment analysis (QPRO)*
.bdm	*bed material analysis (QPRO)*
.trs	*survey bulletin transect plot data (QPRO)*
.dt2 & .ct2	*iso-velocity plot data (MIKE 21)*

The file name conventions have been followed rigorously for the routine surveys and as far as possible also for the special surveys.

Bathymetry files are named as follows:

VP

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Example file name: aug95gor.dt2 and aug95gor.ct2

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aug = month
95 = year
gor = location (Gorai)

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The .dt2 and .ct2 extensions are required for use with the MIKE 21 plotting and editing software. The .dt2 file contains the data and the .ct2 file contains the file header information.

Database directory structure

The files will be stored in directories which are unique to the specific file category (transect, bathymetry or water level) and unique to the date of the survey and the survey location. To illustrate, consider the following directory tree: '

Home	*Category*	*Year*	*Month*	*Location*	*Day*	*File name*
p:\psd24	*\transect*	*\1992*				
		\1993				
		\1994	*\ mar*			
			\ apr	*\baru*		
				\baha	*\02*	
					\03	*\b4431t02.ase*
						\b4831t02.ech
						\b4831t02.ssz
						\b4831t02.sed
p:\psd24	*\bathy*	*\1992*				
		\1993				
		\1994	*\may*			
			\jun	*\aric*		
				\baha	*\02*	
					\25	*\b46y1.ct2*
						\b46y1.dt2

The transect survey location names have been structured in a directory tree, which, at the same time, identifies occasional BWDB or SWMC data. The following abbreviations are used:

aric = Aricha
baha = Bahadurabad
baru = Baruria
bbaz = Bhairab Bazar
bwdb = BWDB
hard = Hardinge Bridge

kush =	*Kushtia*
mawa =	*Mawa*
myme =	*Mymensingh*
aria =	*Offtake Arial Khan*
sira =	*Sirajganj*
swmc =	*SWMC*
till =	*Tilly*

3.3 Data file types

The following information is used to interpret the raw data files and to produce the PSD24 files:

a) Survey Bulletins
b) Field survey reports
c) Sediment laboratory data sheets and reports
d) Water level data

With the use of processing software as described in appendices to the present report, the above information is transformed into the PSD24 data files as explained below.

ADCP/S4/EMF file (.ase file)

This file contains processed ADCP, S4 and EMF data from one transect line including records made at stationary verticals as well as by the moving boat. This file contains all recorded velocity data. The depth information in this file is from the ADCP, whereas calculations of cross section parameters and discharge are based on echosounder depths (which are not in this file). If there are more than one survey along the same line, these data will be stored under separate names. In general, the file has 5 main sections as follows:

1) Main file header block

Contains file information describing the overall transect, i.e. date, start and end positions, water level, width, area, discharge, no. of stationary profiles, no. of moving boat ADCP profiles, etc.

A	A	B	C	D
1	b3b11t05.ase			
2	**********			
3	**FAP24-River Survey Project**			
4	**Flow Velocity File.**	Creation date:	1995-06-11	
5	**********			
6	date	(yyyy-mm-dd)	**1993-11-01**	
7	location		**Bahadurabad**	
8	raw data filename		**b3b11t05**	
9	start position (East North)	(m)	460173.7	784199.6
10	end position (East North)	(m)	460860.1	784498.5
11	total distance transect	(m)	748.66	
12	left bank distance	(m)	50	
13	right bank distance	(m)	75	
14	pos. of left bank	(m)	460905.9	784518.5
15	transect angle lt->rt	(deg)	246.47	
16	water level	(m+PWD)	13.57	
17	total width	(m)	873.66	
18	area (echosounder)	(m2)	3464.49	
19	discharge (ADCP transect)	(m3/s)	2497.23	
20	No. of ADCP verticals		3	
21	No. of S4 verticals		2	
22	No. of manual verticals		2	
23	No. of moving boat ADCP verticals		53	
24	EMF (Yes/No)		No	

2) Stationary profile header block

Contains summary information for each stationary profile. Vertical number labels are appended with an "E" for EMF, "A" for ADCP, or an "S" for S4.

3) Stationary profile data block, with the flow data for each vertical

4) Moving boat profile header block

Contains summary information for each moving boat profile. Moving boat vertical number labels are appended with a "T", meaning "transect" or an "E" for EMF.

5) Moving boat profile data block

Contains the flow data and ADCP backscatter data for each vertical.

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Echosounder file (.ech file)

This file contains processed echosounder data from one transect line. If there are more than one survey along the same line these data will be stored under separate names. In general the file has 2 main sections as follows:

1) Main file header block

Contains file information describing the overall transect, i.e. date, start and end positions, stage level, width, area, mean depth, hydraulic radius, channel asymmetry, etc.

A	A	B	C	D
1	b3b11t05.ech			
2	**********			
3	**FAP24-River Survey Project**			
4	**Echosounder File.**	Creation date:	1995-06-11	
5	**********			
6	date	(yyyy-mm-dd)	**1993-11-01**	
7	location		**Bahadurabad**	
8	raw data filename		**b3b11t05**	
9	start position (East North)	(m)	460173.7	784199.6
10	end position (East North)	(m)	460860.1	784498.5
11	total distance transect	(m)	748.66	
12	left bank distance	(m)	50	
13	right bank distance	(m)	75	
14	pos. of left bank	(m)	460905.9	784518.5
15	transect angle lt->rt	(deg)	246.47	
16	water level	(m+PWD)	13.57	
17	total width	(m)	873.66	
18	area (echosounder)	(m2)	3464.49	
19	hydraulic radius	(m)	3.95	
20	resistance radius	(m)	4.94	
21	wetted perimeter	(m)	877.28	
22	mean depth	(m)	3.97	
23	channel asymmetry		0.66	

2) Echosounder distance/depth data block

A	A	B
25	**********	
26	dist. lt. bk.	depth
27	(m)	(m)
28	0.00	0.00
29	45.00	1.00
30	50.39	2.10
31	51.42	2.20
32	52.25	2.20
33	53.12	2.20
34	55.72	2.30
35	56.68	2.30
36	57.64	2.30
37	58.73	2.30
38	60.82	2.30
39	62.05	2.40
40	63.14	2.45
41	64.19	2.40

Sediment transport file (.sed file)

This file contains processed ADCP backscatter signals and MEX turbidity data. Also, starting from the April 1994 surveys, this file contains sediment transport computations based on results of laboratory analyses of sediment sample data and the calculation method described in section 2. The .sed file will only be there if flow and sediment transport data have been collected at stationary verticals. In general the file has 4 main sections as follows:

1) Main header block (shown on the next page)

Contains file information describing the overall transect, i.e. date, start and end positions, stage level, width, area, discharge, number of vertical profiles, number of MEX profiles, etc. This may be considered as a summary of measurements and calculation result for the transect.

2) Vertical profile header block, with summary information for each stationary profile

3) Stationary profile sediment data block, with the sediment transport data for each vertical

4) MEX turbidity data block, with the MEX turbidity data for each vertical

A	A	B	C	D
1	b3b11t05.sed			
2	**********			
3	**FAP24-River Survey Project**			
4	**Sediment Transport Data File.**		1995-06-11	
5	**********			
6	date		**1993-11-01**	
7	location		**Bahadurabad**	
8	raw data filename		**b3b11t05**	
9				
10	**MEASUREMENTS:**			
11	EMF (Yes/No)		No	
12	No. of verticals		7	
13	No. of ADCP verticals		3	
14	No. of S4 verticals		2	
15	No. of manual verticals		2	
16	No. of moving boat ADCP verticals		53	
17	No. of turbidity (MEX) profiles		3	
18	No. of Helley-Smith samples		0	
19	No. of Delft Bottle samples		0	
20	No. of US BM-54 bed samples		0	
21	No. of Van Veen bed samples		3	
22	No. of point samples		35	
23	No. of depth integrated samples		0	
24	No. of collapsible bag samples		0	
25	No. of susp. sed. size distribution samples		3	
26	**TRANSECT LINE DATA:**			
27	start position (East North)		460173.7	784199.6
28	end position (East North)		460860.1	784498.5
29	total distance transect		748.66	
30	left bank distance		50	
31	right bank distance		75	
32	pos. of left bank		460905.9	784518.5
33	transect angle lt->rt		246.47	
34	**HYDRAULIC AND CROSS SECTION DATA**			
35	water level		13.57	
36	total width		873.66	
37	area (echosounder)		3464.49	
38	hydraulic radius		3.95	
39	resistance radius		4.94	
40	wetted perimeter		877.28	
41	mean depth		3.97	
42	channel asymmetry		0.66	
43	discharge (ADCP transect)		2497.23	
44	discharge (verticals)		2956.05	
45	**SEDIMENT TRANSPORT DATA:**			
46	Helley-Smith tranport		0	
47	susp. load (- wash load)		407.35	
48	wash load		910.9	
49	total sed. transport		1318.25	
50				

Longitudinal profile file (.lng file)

This file contains processed longitudinal profiles. In general the file has 3 main sections as follows:

1) Main header block, with general file information

A	A	B	C	D	E	F
1	b48k1.lng					
2	**********					
3	FAP24-River Survey Project					
4	Longitudinal Profile File.	Creation date:	1995-05-22			
5	**********					
6	date	(yyyy-mm-dd)	1994-08-20			
7	location		Bahadurabad			
8	WL station		bahadurabad	Level	(m)	18.39
9	WL station		aricha	Level	(m)	9.15
10	**********					

2) Longitudinal profile header block, with summary information for each longitudinal profile

3) Longitudinal profile data block, with the data for each profile

Stationary profile file (.prf file)

This file contains processed stationary profiles. In general the file has 2 main sections as follows:

1) Main header block, with general file information

A	A	B	C	D
1	b5411p01.prf			
2	**********			
3	**FAP24-River Survey Project**			
4	**Stationary Profile Data File.**	Creation date:	1995-07-16	
5	**********			
6	date	(yyyy-mm-dd)	1995-04-01	
7	location		Bahadurabad	
8	raw data filename		b5411p01	
9	position (East North)	(m)	469591.0	775357.4
10	flow direction	(deg)	0	
11	water level	(m+PWD)	13.47	
12	No. of ADCP profiles		123	
13	No. of S4 profiles		1	
14	No. of turbidity (MEX) profiles		1	
15	EMF (Yes/No)		Yes	
16				

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2) Stationary profile data block, with processed data for each stationary profile.

Suspended sediment concentration file (.ssc file)

This is a QPRO file containing the suspended sediment concentration laboratory results for all verticals measured in a given transect survey.

Suspended sediment size file (.ssz file)

This is a QPRO file containing the suspended sediment size analysis for all verticals measured in a given transect survey.

Near bed transport file (.bdl file)

This is a QPRO file containing the bed load sediment size analysis for all vertical measured in a given transect survey.

Bed material size file (.bdm file)

This is a QPRO file containing the bed material sediment size analysis for all vertical measured in a given transect survey.

Iso-velocity file (.ct2 & .dt2 files)

MIKE 21 type 2 file. Essentially it consists of a 2-D fixed grid matrix of u-velocities at each fixed grid component. It is necessary to use MIKE 21 to read this data. It is possible to export the data from MIKE21 into a space separated variable file format for input into most spreadsheet programs. Once imported into the spreadsheet, the files can become very large.

Survey Bulletin transect plot data file (.trs file)

This is a QPRO file which contains all of the data which is used to produce the transect plots in the Survey Bulletins. The data is presented in columnar format. The following is a detailed definition of the contents of each column:

Column	Variable	Units	Description
1	dist	m	echosounder dist from left bank
2	z	m	depth below stage level
3	dist	m	ADCP dist from left bank
4	a	m2	cross section area of profile
5	w	m	width of profile
6	u	m/s	velocity perpendicular to run line
7	v	m/s	velocity parallel to run line
8	qt	m3/s	total discharge for profile
9	qs	kg/s	total sed. discharge in prof.
10	qut	m3/s/m	unit total discharge
11	qus	kg/s/m	unit total sediment transport
12	qsw	kg/s/m	unit susp. wash load transport
13	qsus	kg/s/m	unit susp. sediment transport
14	qbed	kg/s/m	unit bed load transport
15	dist	m	sample distance from left bank
16	d50susp	mm	d50 size of suspended sediment
17	d50bedld	mm	d50 of bed load sediment
18	d50bed	mm	d50 of bed material

Bathymetry file (.ct2 & .dt2 files)

MIKE 21 type 2 file. Essentially it consists of a 2-D fixed grid matrix of SLW water depths at each fixed grid component. It is necessary to use MIKE21 to read this data. It is possible to export the data from MIKE21 into a space separated variable file format for input into most spread sheet programs. Once imported into the spreadsheet the files can become very large.

3.4 Paradox catalogue system

All PSD24 data files are listed in a Paradox database table. To access the table, the user must run the Paradox program. To run the program, double-click on the Paradox icon from Windows, type the password, "psd24", and then choose File/Open/Table, and choose the table named:

psd24.db

For each PSD24 file, an entry for each of the following fields is kept:

- Survey bulletin number
- File name
- Location
- Channel number
- River
- Survey type
- File contents
- File location
- Survey date

- File format
- Starting easting
- Starting northing
- Ending easting
- Ending northing
- Online/offline
- Retrieve

Paradox query

To make a search for a particular set of data, the user may choose to run a Query. To perform a Query, choose the menu File/New/Query. Then choose the psd24.db table. The user is then presented with a menu screen showing all the fields in the table. Within each field is a check box and an area to enter the search string. The check box is used to choose which fields will be returned in the Query listing. The search string can be entered as either the entire word, or wildcard variables combined with a partial word. The search strings are not case sensitive by default.

As an example, if the user was interested in finding a list of the file names and file locations for all of the files which contain ADCP data on the Padma River, the user would place a check in the boxes for the "File name" and "File Location" fields, and then enter the search string "..ADCP.." under the "File Contents" field, and then enter "..Padma.." under the "River" field. Note that the search strings contain the ".." characters at each end of the string. The ".." is a wildcard, and can be used when the user is not sure on the exact spelling or format of the entire string. Also note that the search strings are not case sensitive. Once the parameters are selected, choose the menu, Query/Run. After some time, Paradox Query will return a list of all the records found which satisfied the requested search criteria. The query table can be printed, saved, deleted, re-formatted into a Paradox Report, and can also be appended with further Query search listings.

Viewing QPRO files from within Paradox

It is possible to view the individual QPRO formatted files from within Paradox. To view the QPRO files from Paradox do the following:

1) Start QPRO Pro for Windows.
2) Switch to Paradox using the key command "Alt-Esc".
3) Move the cursor to the field labelled "Retrieve".
4) launch the file using the key command "Shift-F2".

The user is recommended to read the Paradox User's Guide for a full description of all features available inside the Paradox system.

Editing of the Paradox database table as well as the files contained within it is not possible, whereby the original database will always remain intact. The user can, however, copy any selected information from the database to other files and edit from there.

4 Other databases

4.1 The HYMOS system

The HYMOS system comprises both the water level data and the tools for their analysis and administration:

- data files (time series of water level)
- data administration routines: Data entry, validation and de-bugging, editing (merging, interpolation, averaging, transformation), data storage
- software routines for hydrological calculations: Velocity-area flow calculation, rating curves and rating curve validation
- software routines for statistical analyses: Correlation analysis, distribution analysis, extreme value analysis
- data presentation routines: Time series, x-y plots, statistical plots

The data files are time series of mean daily water level, one file for each gauging station. The directory name is *RSP.WL*.

4.2 Primary sediment analysis data

The results of the sediment analyses are of an intermediate character within the over-all data flow, but are potentially of a much wider interest, because, as it is the case with other intermediate results of the field programme, they contain a lot of detailed information which is inevitably dimmed during the synthesization. Sediment size distribution curves are included in this database.

The sediment analyses are readily accessible, because they have been catalogued and stored in a standard (QuattroPro) spreadsheet, from where they can be easily retrieved for different purposes. This set of spreadsheet files can be regarded as an independent part of the RSP database.

The structure of the database is self-explanatory to the user, and is shown in the figure below.

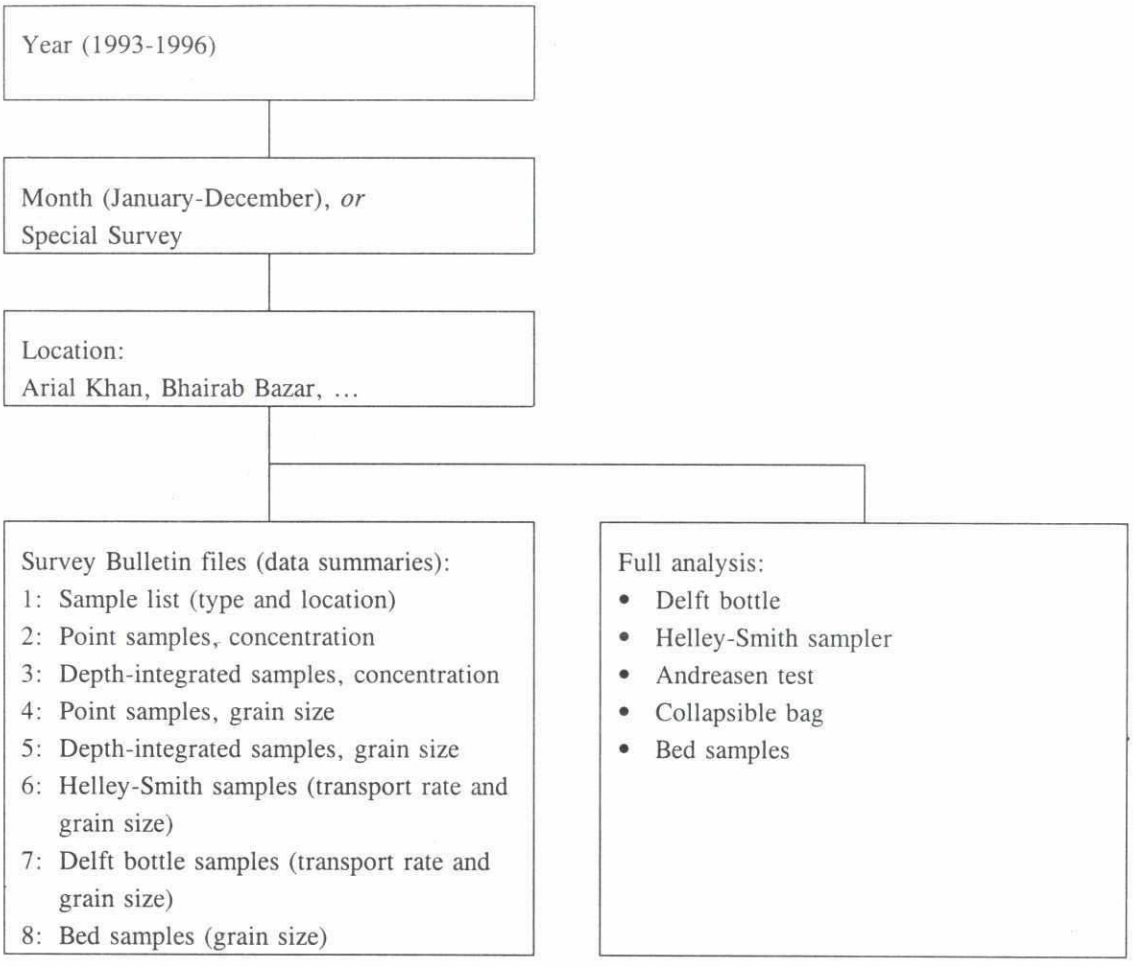

Figure 1: The RSP sediment database

5 Data reporting

The data reporting of the RSP is done at three levels:

(1) the *Survey Reports*, one for each survey, with descriptions of the data collection. These are for internal use and are mainly used during post-processing and quality control

(2) the *RSP Survey Bulletins*, one for each survey. These contain descriptions of the time and place of the survey, a summary of the survey programme, an extract of the results, and a listing of data files

(3) the *RSP Data Books*, covering (i) January 1993 - March 1995, and (ii) April 1995 - March 1996. These contain extracts from the Survey Bulletins: The time and place of the survey, a summary of the survey programme, an extract of the results, and a listing of data files. In addition, the Data Books present hydrographs, and rating curves for flow and sediment transport.

The bathymetric surveys are described in *RSP Survey Report 11: 'Bathymetric Surveys'*.

The structure of the data reporting is shown in Figure 2.

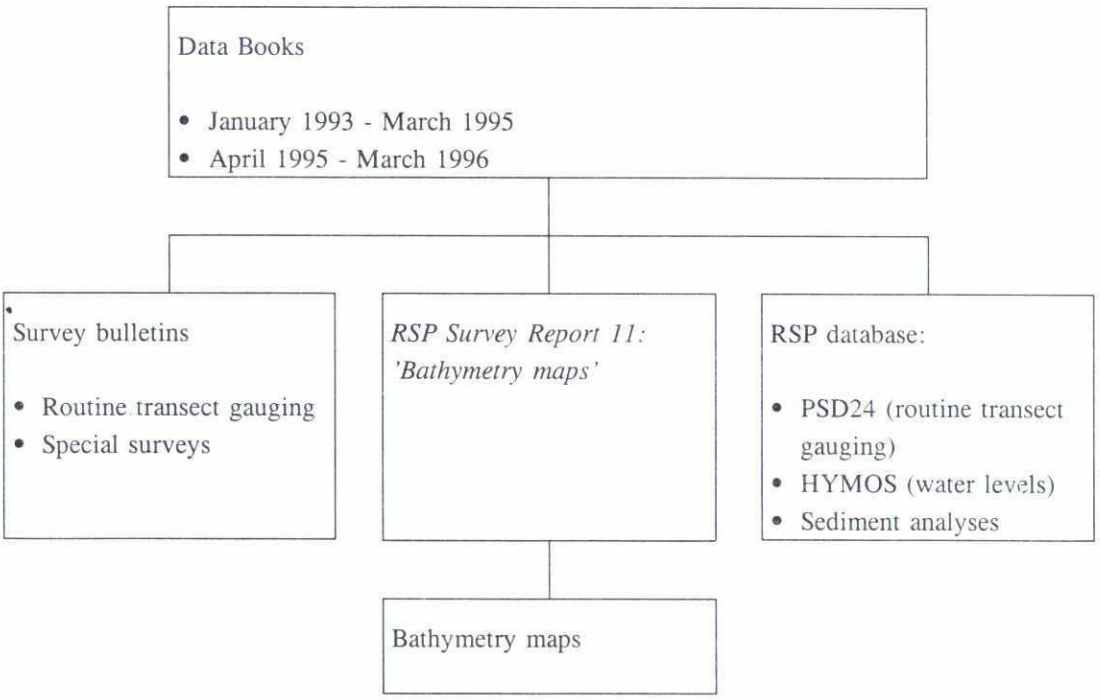

Figure 2: Data reporting of the RSP

6 Calculation methods

The collected data have been through a processing, leading to the figures which can be found in the databases. For a few but crucial sets of these data, the processing involves a calculation, which is based on certain assumptions. This is the case for the *discharge* and for the components of and the total *sediment transport*. In order to make it clear for the users which calculation methods have been applied, the methods are described in detail in the following.

The calculations of discharge and sediment transport are based on results obtained in FAP24 survey of a transect line, ie. a line crossing the flow in a river channel. The calculations both involve integration over the cross section of the channel. The cross section geometry, flow velocities, sediment concentrations and fluxes have been measured along the transect lines. These basic data are applied in the integration. In surveys of a transect line the flow is usually measured both by 'moving boat' (ie. by ADCP while the survey vessel is moving across the channel) and by the traditional method of measuring point velocities in a number of stationary verticals. Sediment data is also obtained both from the moving boat (ADCP backscatter) and from stationary verticals. The ADCP backscatter is, however, not at present considered useful in calculation of sediment transport. The calculated discharge and sediment transport may therefore be based on two different combinations of basic data sets:

- point velocities at stationary verticals together with sediment concentrations and fluxes at stationary verticals
- moving boat velocities together with sediment concentrations and fluxes at stationary verticals

Both of these methods have been used, ie. the PSD24 database and data documentation contain discharge and sediment transport results calculated on the basis of two different combinations of basic data. The relevant sections of this report points out in each case whether 'moving boat velocities' or 'point velocities at stationary verticals' were taken as a basis.

The principles for the calculations of the discharge and sediment transport for a transect explained below apply both for the moving boat measurements and point velocity measurements.

The discharge is calculated by the standard method using the WMO mid section method. The sediment transport calculation is also based on the mid section method, using sediment concentrations measured at a limited number of verticals along the transect (cross section).

6.1 The transect

A transect line is defined as the horizontal line between the start of the survey line (transect) (SOT) and the end of the survey line (transect) (EOT). The actually sailed line which is usually nearly straight will be close but not identical with the transect line. The stationary verticals are also placed near the transect line but in reality a certain distance away from it. The transect line is the fictitious (ie. unmeasured) line to which all measurements are referred for the purpose of calculating the integrated measurement results: discharge and sediment transport. Figure 3 below shows how information from the sailed line and from stationary verticals are transferred to the transect line. The depths along the transect line are found by projection of the echosounder depths recorded by the moving boat along the sailed line, ie. partial cross section areas from the sailed line are projected onto the transect line. The depths at the stationary verticals may be different from the corresponding projected depth of the

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sailed line. The information collected in the stationary verticals therefore need to be transformed to the depth at the transect line. How this is done is shown below.

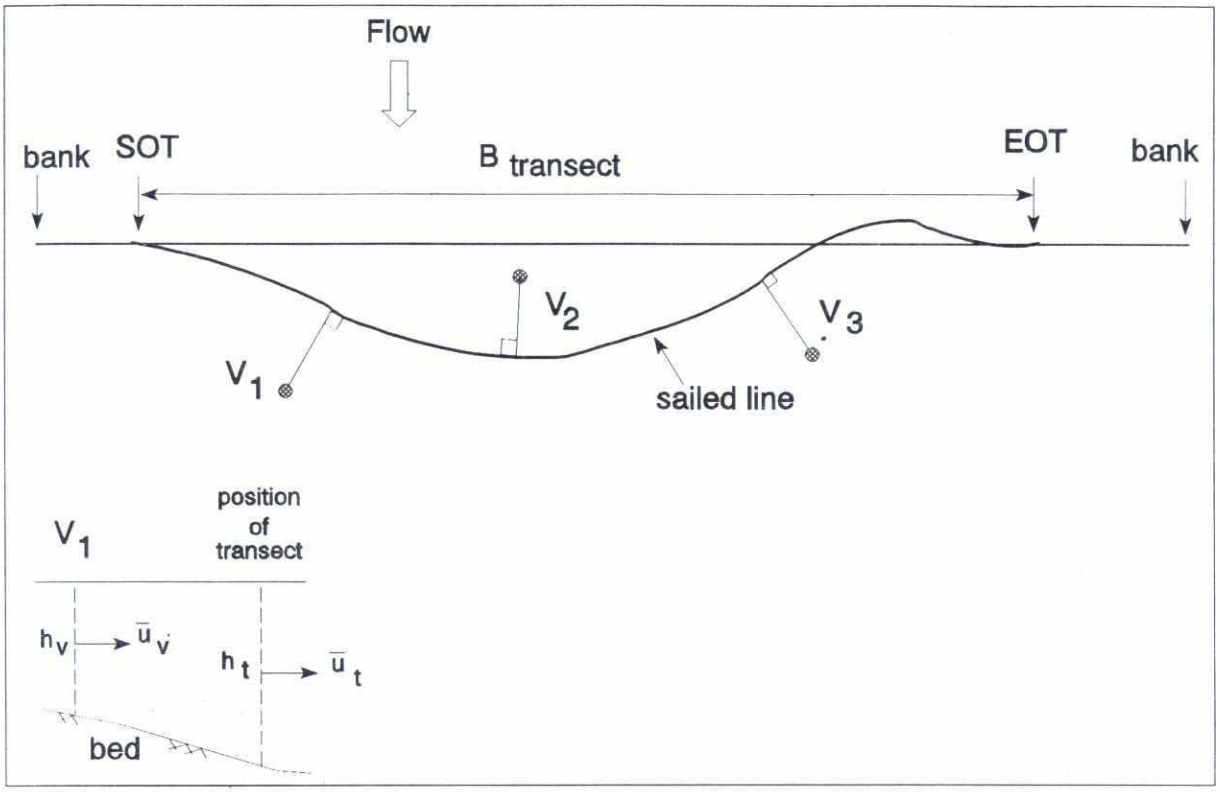

Figure 3: Definition sketch, the transect

The vertical (for instance V_1 in Figure 3) is first projected onto the sailed line, where the distance from V_1 to the sailed line is shortest. From there it is again projected perpendicularly onto the transect line (like any other information from the sailed line).

Flow velocity components and directions are defined according to a right hand coordinate system as shown in the definition sketch below:

left bank:	For an observer facing downstream, the left bank is on the observers left hand side
right bank:	For an observer facing downstream, the right bank is on the observers right hand side
trans. angle:	The angle from a vector pointing North, clockwise to a vector pointing from the left bank to the right bank
x,u directs.:	Positive is downstream and perpendicular to the transect line
y,v directs.:	Positive is perpendicular to (x,u) pointing towards the left bank
z,w directions:	Positive is upwards

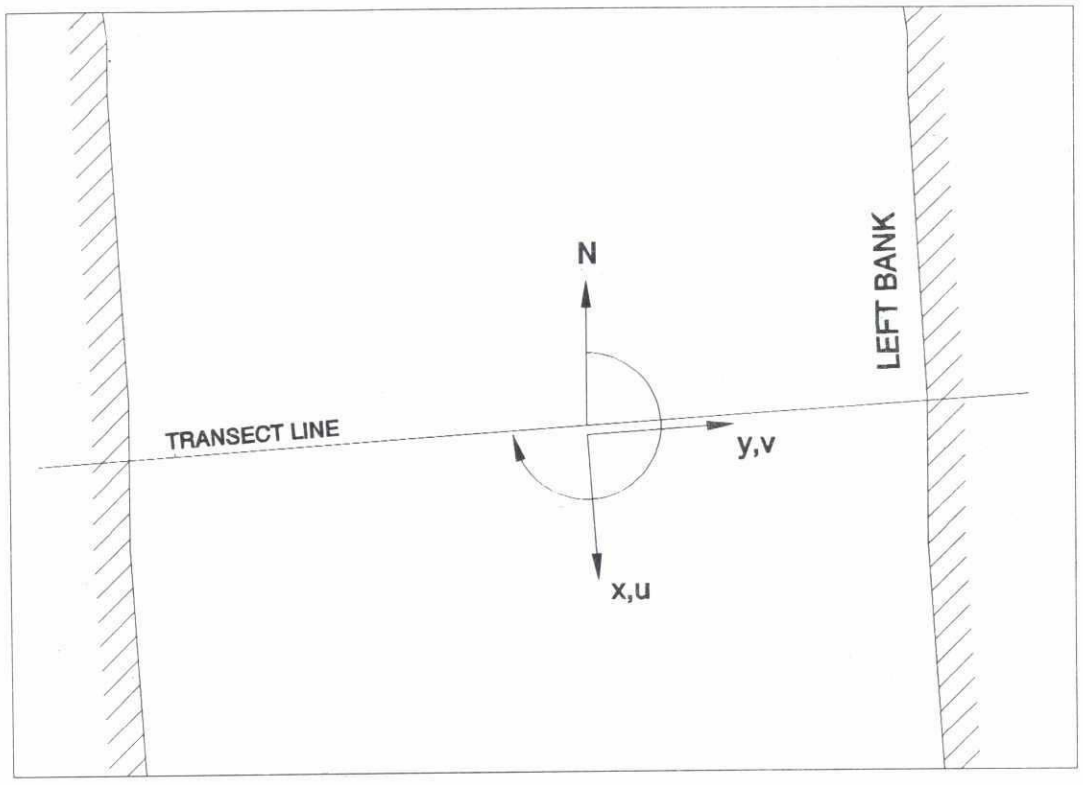

Figure 4: Definition sketch for coordinate system, velocity components and directions

The flow velocity component used in the discharge calculation is the velocity perpendicular to the transect line, $\bar{u}_t$. Assuming cross flow variations to be small compared to variations along flow lines, the specific discharge (m^2/s) is constant discharge and thereby:

$$\bar{u}_t = \bar{u}_v * (h_v / h_t)$$

where $\bar{u}_v$: the depth averaged flow velocity
h_v : the depth in vertical V_i
h_t : the echosounder depth at the sailed line

At stationary verticals the flow velocity is measured by ADCP/EMF or S4 current metre. In the case where the flow velocity $\bar{u}_v$ in the vertical V_i is measured by S4 current metre, the total depth h_v is defined as:

if the echosounder depth $<$ 5 metre: $h_v = h_j + 0.38$
if the echosounder depth $>$ 5 metre: $h_v = h_j / 0.8$

where h_j is the depth of the S4 in its lowest position and 0.38 metre is the minimum distance of the S4 pressure cell from the bottom.

6.2 Discharge calculation

The depth averaged flow velocity at profile k with $h_0 = 0$ metre is (see Figure 5c):

$$\bar{u}_k = \frac{1}{h_{total}} \left[\sum_{i=1}^{j} (h_i - h_{i-1}) \frac{u_i + u_{i-1}}{2} + (h_{total} - h_j) \times u_j \times 0.857 \right]$$

where $u_0 = u_1$. The factor 0.857 (=7/8) on the last term of this sum takes into account the curvature of the lowest part of the velocity profile. It is based on the assumption that the vertical profile has the shape of a power function (power 1/7), Ref. /WMO/.

The total discharge for the transect, considering only the surveyed part, is:

$$Q_{transect} = \sum_{k=1}^{n} A_k \times \bar{u}_k$$

where A_k is the partial cross section area around profile k based on the echosounder record.

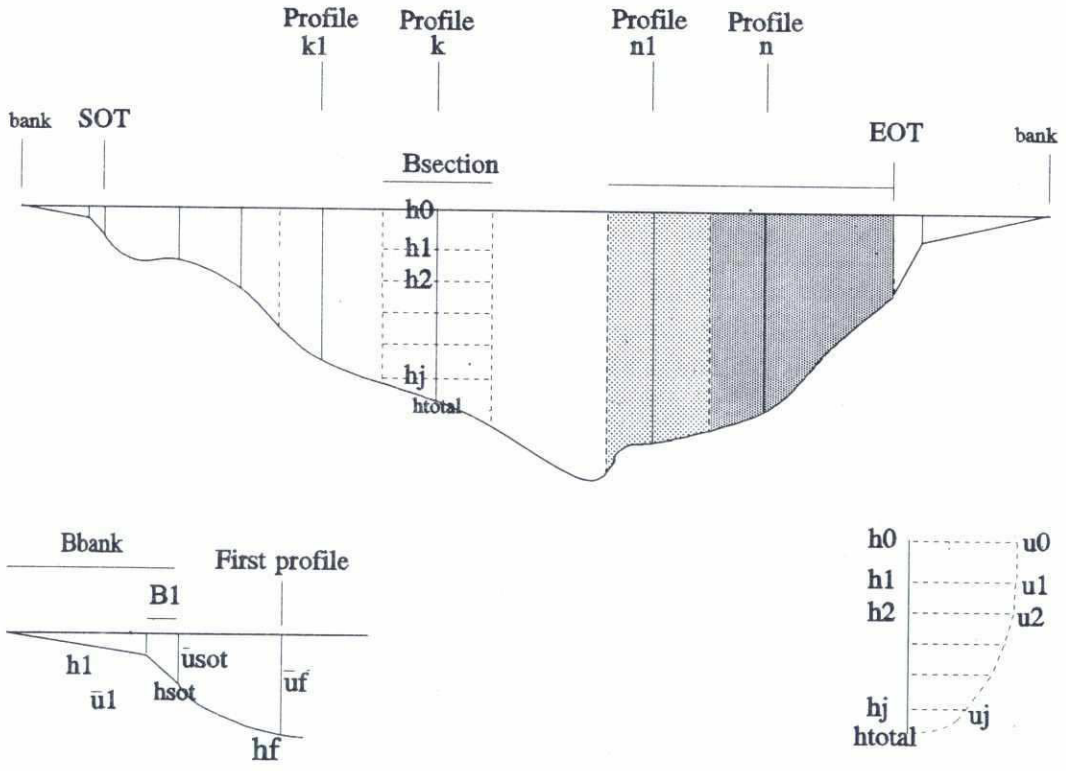

Figure 5: Definition sketch, discharge calculation

The above calculation of the discharge across the transect line excludes the discharge through the unsurveyed parts of the cross section near the two river banks. These contributions (from river bank to SOT and from EOT to the other river bank) are calculated in the following way:

The discharge between river bank and SOT (Figure 5b):

$$Q_{bank} = \frac{\bar{u}_1}{2} \times h_1 \times (B_{bank} - B_1) + \frac{\bar{u}_1 + \bar{u}_{SOT}}{2} \times \frac{h_1 + h_{SOT}}{2} \times B_1$$

where

B_{bank} : estimated distance from SOT to the river bank
B_1 : minimum of (17 metre , B_{bank} / 10)
(17 m=half vessel length, ie min. Distance of from ADCP to bank)
h_1 : =1 metre
$\bar{u}_1$: = $\bar{u}_f * (h_1 / h_f)^{1/2}$
$\bar{u}_{SOT}$: = $\bar{u}_f * (h_{SOT} / h_f)^{1/2}$
$\bar{u}_f, h_f$: depth averaged flow velocity and depth at the first profile

A similar expression is used to calculate the discharge from EOT to the river bank. The applied velocity transformation from one depth to another along the cross section assumes stationary flow with uniform energy slope along the cross section.

The total (water) discharge for the cross section is:

$$Q_{total} = Q_{firstbank} + Q_{transect} + Q_{lastbank}$$

The applied unit is m^3/s.

6.3 Sediment transport calculation

The calculation of the sediment transport through a cross section (across a transect line) is based on measurements of cross section geometry, flow velocities, sediment concentrations and sediment fluxes. Sediment measurements are carried out at a number of stationary verticals. The sediment transport calculation is based on certain assumptions about how these measurements at discrete verticals represent the conditions in between verticals and in the unmeasured part of the cross section near the two banks.

The sediment concentrations are determined from laboratory analyses of water samples from a vertical. To find the sediment concentration C in the position V with depth h_c somewhere between two verticals, V_1 and V_2, the following method is used (see Figure 6):

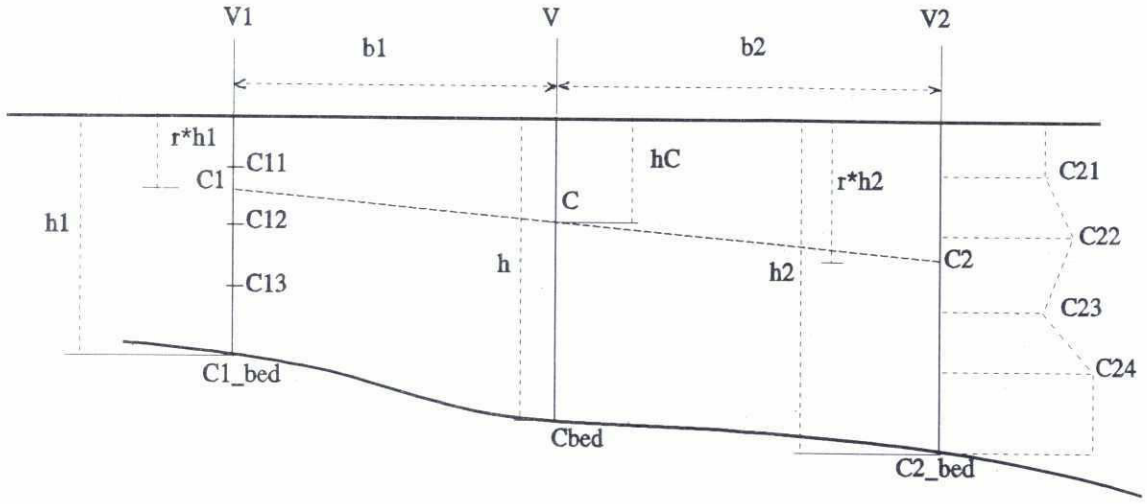

Figure 6: Definition sketch, sediment transport calculation

- The unified depth, r, is defined as $r = h_c / h$
- The sediment concentration C_1 in vertical V_1 at the depth $r * h_1$ is calculated by linear interpolation between C_{11} and C_{12} , and similarly for C_2 between C_{22} and C_{23}

The sediment concentration, C is then:

$$C = \frac{C_1 \times b_2 + C_2 \times b_1}{b_1 + b_2}$$

This method is used both for concentrations of suspended bed material and concentrations of wash load.

The sediment flux, f, defined as $C \cdot u$, is measured near or at the river bed by Helley Smith or Delft Bottle samplers. For interpolation, a relation similar to the one above is used:

$$f_{bed} = \frac{f_{1\text{-}bed} \times b_2 + f_{2\text{-}bed} \times b_1}{b_1 + b_2}$$

For the area between the first vertical, V_1, with sediment measurements and the river bank, the applied concentrations and fluxes are (Figure 7):

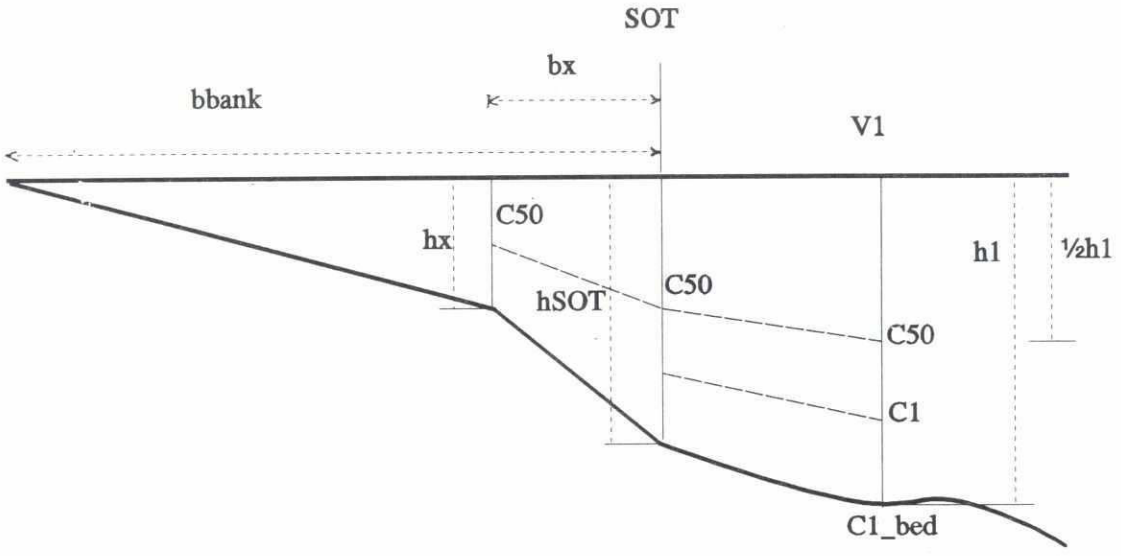

Figure 7: Definition sketch, near-bank sediment transport

In Figure 7 h_x = 1 metre and B_x is the minimum of 17 metre and one tenth of B_{bank}.

In the area between SOT and the first vertical:

- the sediment flux at the bed, f_{bed} is constant (f_{1_bed}).
- the sediment concentration, C (wash load and suspended bed material load) is taken to be the same as measured in the vertical V_1 at corresponding relative depths.

In the area between SOT and the river bank:

- the sediment flux at the bed, f_{bed} is constant (f_{1_bed}).
- the sediment concentration, C (wash load and suspended bed material load) is constant $=C_{50}$, where C_{50} is the sediment concentration from the first vertical at the half depth.

Sediment concentrations and fluxes between the last vertical and the river bank are estimated in a similar way.

The sediment transport components, near bed transport, suspended bed material load, wash load, are calculated separately. The calculations are based on the mid-section method (see Figure 5a).

With Cw and Cs denoting concentrations of wash load and suspended bed material load, respectively, the transport components are calculated for each part section by:

$$S_{wash} = \left[\sum_{i=1}^{j} (h_i - h_{i-1}) \frac{u_i \times Cw_i + u_{i-1} \times Cw_{i-1}}{2} + (h_{total} - h_j) \times u_j \times 0.857 \times Cw_j \right] \times B_{section}$$

S_{susp} : As for S_{wash} ,substituting Cs_1 ... Cs_j for Cw_1 ... Cw_j.

$$S_{bed} = B_{section} \times f_{bed} \times \frac{|u_j|}{u_j}$$

$$S_k = S_{wash} + S_{susp} + S_{bed} \qquad [\text{ kg/s }]$$

where $f_{bed} = C_{bed} \times u_{bed}$

The sediment transport for the transect (from SOT to EOT) is:

$$S_{transect} = \sum_{k=1}^{n} S_k$$

The sediment transport in the area between the river bank and SOT (see Figure 5b) is:

$$S_{bank} = \frac{u_1}{2} (Cw_{50}+Cs_{50})(B_{bank}-B_1) + \frac{\bar{u}_1+\bar{u}_{sot}}{2}(Cw_{50}+Cs_{50}) \times B_1 + C_{1\text{-}bed} \times B_{bank}$$

The total sediment transport for a cross-section is:

$$S_{total} = S_{firstbank} + S_{transect} + S_{lastbank} \qquad [\text{ kg/s }]$$

References

HYMOS manual. Delft Hydraulics

Mike21 Pre- and Postprocessing Manual. Danish Hydraulic Institute

Paradox Manual. Borland

QuattroPro Manual. Borland

Van Rijn, L. C. (1986): Manual, sediment transport measurements. Delft Hydraulics Laboratory, March 1986

World Meteorological Organization (WMO), 1994. Guide to hydrological practices - data collection and processing, analysis, forecasting and other practices, WMO No. 168, 5th Ed., Geneva, Switzerland

G2

Enclosure A:

Introduction to PSD24 software

ADCP/S4/EMF file (.ase file)

Run the program Psd24Ase (UNIX) for each channel transect as presented in the Survey Bulletin. For the older Survey bulletin data use the transect data which was used for the discharge calculation reported. Also included are the stationary profile files, even if they are not used for the discharge calculation.

The Psd24Ase program is used similarly to the other FAP24 Offline software, and uses the following input specification:

Usage:

Psd24Ase
topmethodT topmethodP
left_bank_dist(m) right_bank_dist(m)
firstfixno lastfixno
pwd(m)
transfilename
[proffilename no1 proffilename no2 ...]
[-mode mode]
[-mancurr filename no5 no6 ...]
[-S4factor factor]
[-depthcorr x(m)]
[-shift_left_right]
[-gpscorrT] [-gpscorrP]
[-adcprotT angle] [-adcprotP angle]
[-emfrotT angle] [-emfrotP angle]
[-adcpfreqT freq.(kHz)] [-adcpfreqP freq.(kHz)]
[-adcp_offsetT offset(m)] [-adcp_offsetP offset(m)]
[-fsT frequence(Hz)] [-fsP frequence(Hz)]
[-lcT number] [-lcP number]
[-lsT number] [-lsP number]
[-midbin1T distance(m)] [-midbin1P distance(m)]

(Please refer to the *FAP24 Offline Software Manual* for a complete description of input parameters)

The output from this file will be a DOS formatted ASCII file with the name:

transect_filename.ase

It is then converted to QPRO format using the macro program:

p:\psd24\psd24mac.wb1

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Echosounder file (.ech file)

Run Psd24Ech (UNIX) for each channel transect as presented in the Survey Bulletin.

The Psd24Ech program is used similarly to the other FAP24 Offline software, and uses the following input specification:

Usage:

```
Psd24Ech
 transfilename
 left_bank_dist(m)
 right_bank_dist(m)
 pwd(m)
 [-ech_dist x(m)] default 0.0
 [-depthcorr x(m)] default 0.0
 [-shift_left_right]
```

(Please refer to the *FAP24 Offline Software Manual* for a complete description of input parameters)

The output from this file will be a DOS formatted ASCII file with the name:

transect_filename.ech

It is then converted to QPRO format using the macro program:

p:\psd24\psd24mac.wb1

Sediment transport file (.sed file)

Run Psd24Sed (UNIX) for each channel transect as presented in the Survey Bulletin.

The Psd24Sed program is used similarly to the other FAP24 Offline software, and uses the following input specification:

Usage:

```
Psd24Sed
topmethod
left_bank_dist(m)
right_bank_dist(m)
firstfixno
lastfixno
PWD(m)
transfilename
proffilename no1 proffilename no ...
[-depthcorr x(m)]
[-mode mode]
[-shift_left_right]
[-gpscorr]
[-adcprot angle]
[-emfrot angle]
[-adcpfreq frequency(kHz)]
[-adcp_offset offset(m)]
[-fs frequency(Hz)]
[-lc number]
[-ls number]
[-midbin1 distance(m)]
[-const_backscatter const]
[-S4factor factor]
[-s sedifilename]
[-mancurr filename no1 no ... ]
[-d50 grainfilename]
```

(Please refer to the *FAP24 Offline Software Manual* for a complete description of input parameters)

The output from this file will be a DOS formatted ASCII file with the name:

transect_filename.sed

It is then converted to QPRO format using the macro program:

p:\psd24\psd24mac.wb1

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Longitudinal profile file (.lng file)

Run Psd24Lng (UNIX).

The Psd24Lng program is used similarly to the other FAP24 Offline software, and uses the following input specification:

Usage:

```
Psd24Lng mindist no_of_wl_stat
 wl_station_1  x.xx
       .          .
 wl_station_n  x.xx
 transfilename_1 fstfix lstfix depthcorr swapdir
       SOL_wl EOL_wl SOL_east SOL_north EOL_east EOL_north
[. . . .
        . . . .]
[transfilename_n fstfix lstfix depthcorr swapdir
       SOL_wl EOL_wl SOL_east SOL_north EOL_east EOL_north]
[-lngfilename lngfilename]
[-printfix] (default off)
[-location location]
[-mindepth depth] (default 0.1m)
```

(Please refer to the *FAP24 Offline Software Manual* for a complete description of input parameters)

Stationary profile file (.prf file)

Run Psd24Prf (UNIX).

The Psd24Prf program is used similarly to the other FAP24 Offline software, and uses the following input specification:

Usage:

```
Psd24Prf
 proffilename proffileno starttime stoptime PWD flowdir
 [-S4factor factor]
 [-gpscorr]
 [-adcprot angle]
 [-emfrot angle]
 [-adcpfreq freq.(kHz)]
 [-adcp_offset offset(m)]
 [-fs frequence(Hz)]
 [-lc number]
 [-ls number]
```

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[-midbin1 distance(m)]

f.ex.: Psf24Prf b5b11p01 3 11:00:00 13:59:59 17.96 179 \ -adcprot +2 -emfrot -40

(Please refer to the *FAP24 Offline Software Manual* for a complete description of input parameters)

Script file

The script file used to run Psd24Ase, Psd24Ech and Psd24Sed is combined into a single file and it has the filename:

b4321

where:

b = location, Bahadurabad
4 = year, 1994
3 = month, March
2 = day, 2
1 = vessel number, DHA

Transect plot data file (.trs file)

This is the same file as used for making the transect plots for the Survey bulletins. The first step to produce this file is to run the UNIX programs:

DischProf - if only stationary profile measurements exist.
DischTrans - if ADCP moving boat transect data was measured

The DischProf program uses the following input specification:

Usage:

DischProf mode topmethod
firstdist(m) lastdist(m)
firstfixno lastfixno
transfilename
proffilename proffilename ...
[-s sedifilename]
[-d50 grainfilename]
[-mancurr filename]
[-gpscorr]
[-depthcorr x(m)]
[-adcprot angle]
[-emfrot angle]
[-plotcross filename]

[-plotdisch filename]
[-S4factor factor]
[-changeflow]
[-adcpfreq frequency(kHz)]
[-adcp_offset offset(m)]
[-fs frequency(Hz)]
[-lc number]
[-ls number]
[-midbin1 distance(m)]

(Please refer to the *FAP24 Offline Software Manual* for a complete description of program usage)

The DischTrans program uses the following input specification:

Usage:

DischTrans filename mode
topmethod btmmethod
firstdist(m) lastdist(m)
firstfixno lastfixno
[-gpscorr]
[-changeflow]
[-depthcorr x(m)]
[-adcprot angle]
[-emfrot angle]
[-s sedifilename]
[-d50 grainfilename]
[-plotdisch filename]
[-adcpfreq frequency(kHz)]
[-adcp_offset offset(m)]
[-fs frequency(Hz)]
[-lc number]
[-ls number]
[-midbin1 distance(m)]

(Please refer to the *FAP24 Offline Software Manual* for a complete description of program usage)

Using the -plotdisch option to produce a lot file produces the input to the DISCH program.

The output from DISCH.EXE is a formatted ASCII file with the name:

transect_filename.trs

It is then converted to QPRO format using the macro program:

p:\psd24\psd24mac.wb1

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MIKE 21 iso-velocity plot data (.ct2 & .dt2 and .inp files)

This is the MIKE 21 plot file which is used to produce the Iso-velocity plots for the survey bulletin.

The output file will be MIKE 21 binary formatted files with the name:

transect_filename.ct2 , .dt2 and .inp

MIKE 21 bathymetry plot data (.ct2 & .dt2 file)

This is the MIKE 21 plot file which is used to produce the bathymetry plots.

The output file will be a MIKE 21 binary formatted file with the name:

aug95gor.ct2 & .dt2

where:

aug = month (August)
95 = year (1995)
gor = location (Gorai)

Bed load, bed material and suspended sediment size (.bdl, bdm & .ssz)

These files are produced by combining QPRO spreadsheets produced by the sediment laboratory. The sediment lab spreadsheets are combined, putting all samples into a single file using a QPRO macro. Different macros are used depending on when the sediment data was processed because the file formats have changed a few times since the beginning of the project.

Suspended sediment concentration (.ssc)

These files are produced by combining QPRO spreadsheets produced by the sediment laboratory. The sediment lab spreadsheets are combined, putting all samples into a single file using a QPRO macro. Different macros are used depending on when the sediment data was processed because the file formats have changed a few times since the beginning of the project.

Administration of Paradox catalogue system

The Paradox catalogue will include a record for each file entered into the PSD24 file system. Only the database manager will have privileged access to write new information to the PSD24 catalogue. The catalogue is contained within a file called a Table, and has the file name:

psd24.db

There are various ways of entering data into the table. The first and most direct is to open the table, and then to manually enter each data field for each record. Because of the large number of data records which will be produced, this will normally require too much manual effort. Another method of data entry is to first open the table, and then open the Paradox form named:

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psd24.fsl

The form is a convenient way of entering or editing data within each file record. Manual data entry directly into the table or using the form should only be used for the bathymetry data and water level gage records or for editing existing data fields.

To facilitate semi-automatic record entry for the transect records, a FORTRAN program,

maketabl.exe

has been developed. The program 'maketabl' has the following input/output specifications:

Input: raw transect file name
river channel number
starting and ending coordinates

Output: Paradox PSD24 table records for each of the 9 different transect file types in Comma Separated Value (CSV) format for direct input into Paradox table.

The output file name is

survey_bulletin_number-channel number.txt

Using the input parameters and decoding the file name, the program is able to create table records for all 9 transect files, whether they exist or not. The database manager must delete the lines which do not apply to the particular transect. They should be deleted from the Paradox table using the Ctrl-Del command in Edit mode.

To import the ".txt" file into Paradox, use the Files/Utilities/Import command and import the file 'table.prn' into a temporary table. Use the delimited text format. Next use the Files/Utilities/Add command to append the temporary table to the PSD24 table, 'psd24.db'.

The final task is to manually edit the field which indicates whether the file has been placed online to PSD24.