World Meteorological Organization
Regional Association VI.
Working Group on Hydrology

Draft report for WMO RA VI

SEDIMENT TRANSPORT

Survey

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WMO REGION VI.
REPORT
WGH – MONITORING SEDIMENT TRANSPORT

Content

WMO
REGIONAL ASSOCIATION VI
WORKING GROUP ON HYDROLOGY
REPORT, 07.2000

1. Collection information through questionnaires

On the basis of the Terms of Reference a circular letter with a questionnaire was formulated and disseminated to 50 countries (Annex 1.). The circular was mailed on January 2000 to the addresses of the relevant contact persons: permanent representatives (PR) of the Member countries, hydrological advisors to PRs, members of the Regional Association (RA) VI Hydrological Working Group.

The replies started to flow by 17. January 2000. Most of the countries sent a single reply in the form of the questionnaire, few countries sent only a message that they are working on the replies. 24 Member countries sent answer. Several countries did not reply at all, one country indicated inability in answer. Germany submitted answer of 7 provinces (Land) in addition to the central service.

The number of the different answers indicated diversity in the monitoring of the sediment transport.

The second round of the survey and the review of the draft report started in April 2000 and finished in June 2000, when 10 countries made comments to the draft report until the deadline. Among them. 3 new countries answered by filling questionnaires (Azerbaijan, Norway and Russia). Few countries slightly modified their previous replies or gave additional information. One country made comments to the report in text.

After June one country, Sweden sent an answer by filling the questionnaire, and one country, Bulgaria replied by a one page text. These late answers made the number of the countries who replied 29 (see Table 3).

Thus, 27 Member countries replied finally within the survey, two countries gave a negative reply, e.g. no sediment measurement in the countries (Ireland and Belgium). Some countries reflected by supplying partial information, particularly related to financial data.

The Member countries tried to reply the questions wherever it was possible and answered properly. In certain questions few countries did not reply or sent an unproper answer. In this case in the integrated table **no** or **misunderstood** reply are indicated. The original questionnaires were collected and serve as basic material for the survey.

The integrating table has been prepared in the alphabetic order of the countries using their English names (Summary of the tables containing replies).

The replies contain only two additional informations, the reports of Germany and Switzerland (Rhine). These additional materials exist only in German language (with an exception). Of course, the basic aim was to collect information with the questionnaire, and it was not foreseen to get more detailed material. The report of Slovenia includes a hydrological year book from 1997.

However, one may note that some countries executed projects previously and made an intercomparison, like Delft (the Netherlands) made a few years ago jointly with Jaroslav Cerny Institute (Belgrade). These reports were mainly of methodology oriented.

The WMO Technical Regulation (Volume 3. Hydrology) includes regulations on sediment monitoring, and the Guide to Hydrological Practices contains chapters on sediment monitoring network and on the measurement of suspended sediment. WMO also published a Manual. These publications should also be considered as basic material for the survey.

2. Evaluation of the questionnaires through tables

The Questionnaires cover 5 pages. From the replies 14 tables could be summarized. The summary table includes the list of countries, who replied, in alphabetical order.

Table 1.	shows the introduction length of the period of the monitoring in year for suspended sediment, bed load and bed material.
Table 2.	includes the number of stations (1999), frequency of sampling
Table 3.	characterizes the sampling (separated, jointly, combined methodology)
Table 4.	gives information on the sampling points
Table 5.	shows the value of the mean relative error
Table 6.	offer information on periods of sampling
Table 7.	shows the instruments used in the network
Table 8.	informs the reader about standardization
Table 9.	summarized data processes on concentration, grain size distribution, or sampled mean weight
Table 10.	indicates the data storage
Table 11.	offers data on estimated annual costs
Table 12.	introduction the share of the total costs
Table 13.	shows the manpower demand
Table 14.	Characterizes the form of international co-operations.

The collected answers are of either **yes** or **no** type, providing technical or financial numerical values.

3. General evaluation of the replies

According to the comparisons, suspended sediment is (or was) sampled almost in every countries of the survey. The starting date of the established suspended sediment monitoring goes back to the early thirties of XX. Century. With certain exceptions the period of the regular monitoring depends on the establishment of the hydrological service.

The network composed by the stations includes mainly suspended sediment monitoring. The frequency of the sampling varies within wide ranges from daily to annual frequency.

The other influencing aspects evidently are the density of the network and the sampling costs which ranges from a few thousand to hundred thousands US$. The data are rather uncertain.

Standardizations are mainly on the field of suspended sediment, both at national and international level.

International co-operation in the field of sediment sampling/processing, is mainly directed for suspended sediment data exchange up to joint measurement of the sediment.

Thus, about 60% of the countries in RA-VI answered for the circulars, and 26 countries replied by filling the questionnaires while, 3 countries sent short written statement.

In certain cases reply was misunderstood and corrections may be requested. Where **yes** or **no** answer is relevant, an asterix (X) indicates **yes** and "-" symbol means either "**no**" or it means "**no answer**".

The dates are referring to the decades of the last (XX) century (e.g. 46 means 1946).

4. Density of sediment monitoring network

Design of sediment monitoring networks is based on the minimum density principle (a) either by measurement of the erosion, transport and deposition of the sediment within the country, (b) or by measurement the total sediment discharge to the ocean. An optimum network would contain a sediment station at the mouth of each important river discharging into the sea. Streamflow records must be collected at all stations where sediment transport is measured. Therefore, the sediment transport monitoring stations should be so located that they can function as components of the minimum streamflow networks.

The Guide to Hydrological Practices (Vol. I) Fourth edition (1981) recommends that sediment transport be measured of the following percentages of the stations in the minimum network of stream gauges – considering the European conditions - :

Arid regions/Mediterranean regions	30 per cent
Humid temperate	15 per cent.

These percentages can serve as guides in establishing a minimum network. Considering the minimum density of hydrometric (stream gauging) stations the following minimum density is required:

Flat regions of temperate or mediterranean zones	1000- 2500 km^2/station
Mountainous regions of temperate or mediterranean zones	300- 1000 km^2/station

Arid zones (without great deserts) 5000-20000 km^2/station

From the two aspects one can conclude that under European normal conditions the minimum sediment monitoring network-density is between

(a) 1000-3000 km^2/station;
and for extraordinary conditions
(b) 3000-10 000 km^2/station.

According to the questionnaires the existing network density is rather within the range of the extraordinary condition, then within the normal minimum density, thus the operation of the existing stations is highly desirable.

5. Exceptional cases

In the case of Germany 7 Lands (Province) indicated data in addition to the federal network which are given at the end of the Summary Table.

Several data in the questionnaires are relevant, but they can not be interpreted, therefore they are not indicated in the Summary Table. In general, quite a lot of questions were not answered by the countries, therefore there are not evaluated in the Summary Table.

Two countries, Germany (Federal) and Switzerland submitted up-to-date reports which are interesting but it is difficult to intercompare them with the submitted data, therefore they are not included in the Summary Table.

6. Content of summary table

From the questionnaires a summary Table 1. was established, including some major features of the monitoring network. The summary table covers the three main types of sediments: suspended (SS), bedload (BL) and bedmaterial (BM), namely

- the date of introduction of monitoring
- the length of the period of monitoring
- the number of stations
- the frequency of the annual monitoring
- the total costs of the annual sediment monitoring
- the use of national or international standardization
- the international co-operation.

Surveying the answers given to the questions 6, 7 and 8 of the present questionnaire (Table 2.) leads to the following conclusions:

1. Altogether 26 countries (without the German Lands) specified the suspended sediment sampling methods used by them. Interestingly, ten of them still use the traditional milkbottle technique. In five countries the electro-optical turbidimeters are applied, however, nine of them use pumping with or without in-situ filtering. In three cases the answer "other" are given not specifying the name of the instrument.

2. Hydrophone and/or underwater video in three cases observe the sediment movement besides sampling. Bed load is sampled in eight countries altogether. Two countries mention tracing methods also.
3. Bed material is sampled in nine countries, mostly by scraping, i.e. obtaining disturbed samples.
4. The laboratory practices consist overwhelmingly of filtering and drying. More sophisticated method (sedigraph) is mentioned once only.
5. In the free space at the end of the questionnaire several countries claim Financial restrictions by the home government and only plan to purchase modern equipments and apply up-to-date sampling and processing methods. It seems that the sediment processes gain unduly small interest among the hydrological events by the decision makers This also involves insufficient share of sediment problems in the engineering education and a lack of properly trained field staff.
6. Another problem observable in several countries that the sediment data collection is made separately by two-three governmental agencies (ministries) without exchanging the obtained data with each other. As a result of this organization, the finance, energy and manpower devoted to data collection have got a rather low utilization.

7. Evaluation of the replies on the questionnaires

The replies on the questions of the circular are not complete, almost no country answered completely. The lack of the missing information shows that hydrological services gave a low interest for sediments among other monitored parameters. In certain cases the deterioration of the sediment monitoring network can be observed, from the replies even an abrupt change in the sediment network could be detected.

The introduction of sediment monitoring started in Europe 80-20 years ago, thus the observation period – at least for suspended sediment measurement – is of 70 years. Due to World War 2. there is an interruption in the data collection mainly in the forties of the XX. Century. Several countries had 30-40 years periods for suspended sediment sampling, but bed load measurements had much lower interest.

The number of monitoring (observation) stations is the most characteristic value, since density of the sediment network can be intercompared in relation with the size of the country (Table 3.). In certain countries there are more stations and rare sampling (e.g. France has 1540 observing stations and only monthly one sampling). While suspended sediment samplings can be found acceptable, bed load and bed material are almost not sampled at all. It seems that bed load sampling is only in a introductory stage. Among the 29 countries only 10 countries had bed load sampling, even with a low frequency. In several case only monthly or weekly sampling of the suspended sediment may be characteristic. It was rather surprizing to note that frequency of the sampling – in general – is rather low. In several cases monthly or bimonthly sampling intervals should be acceptable. Bed material sampling intervals are even more longer.

The cost aspects of the sediment monitoring show an even worse situation, several countries could not submit any data on the financial conditions. The budget for sediment sampling is almost negligable, and low share from the finance of the

hydrological services can be concluded. The highest value is even less than 200.000 US$ and the percentage is about 1-2% of the total hydrological service costs.

Two aspects of the status of the sediment monitoring indicate interest on behalf of the countries.

Relatively a high number of countries standardized the measurements, particularly related to suspended sediment. Almost every country uses national or international standards.

International co-operation is particularly characteristic on the shared river basins (Rhine, Danube), but it is almost restricted to suspended sediment, bed load international programmes are executed in Germany, the Netherlands, and Switzerland. The survey shows that internationalization of sediment monitoring needs reinforcement, and bed-load sampling programmes, particularly, on international rivers should be encouraged.

There is rather discouraging that data on manpower needs are almost missing. Data processing covers mainly the collection of measured data, and only few services have data bank devoted to sediments. Even there are services without processes or evaluation of data. In certain cases the hydrological yearbooks contain also sediment data.

The estimation of the uncertainty of the sediment data shows that most services either do not have opinion or they are estimating high values, as errors (e.g. 20% or more, as average).

The transport rate (sediment discharge) is an important factor and the services try to make calculations from the velocity and sediment concentration measurements in order to integrate annual values. It is regrettable that several countries did not indicate availability of transport rate values, as output of the measurements.

Several instruments are available for sampling, however the most frequently used is still the bottle. Surprizingly there were relatively less countries where water quality and suspended sediment samplings are executed simultaneously. The problem is, probably, that the two samplings are within the competence of different services and the national hydrological service is not responsible for the water quality sampling. Therefore, the networks are different. It is clear that efforts would be necessary to integrate the two networks into one single one, or at least joint monitoring cross-sections should be selected.

8. Shortcomings of the report

It is regretted that financial data are either missing, or the values are questionable, thus the cost aspects can not be over viewed, or intercompared.

Some important countries did not answer or their answer is incomplete.

When evaluating the replies, one may conclude that certain replies gave only partial information. The data on cost aspects (questions 10, 11) and manpower (question 12) are inadequate.

Few questions were misinterpreted, and replies are not appropriate.

9. Conclusion

The overview on the 27 country values offers a comprehensive picture concerning the state of sediment monitoring.

The main conclusions can be drawn, as follows:

1. Suspended sediment monitoring can be sufficient in few countries, while bed load and bed material is not covered sufficiently;
2. Data collection on suspended sediment can be acceptable in several countries, but the other two components are missing in the national hydrological networks;
3. The finance related to sediment monitoring is absolutely insufficient
4. International collaborations are weak, and promotion of co-operation and data exchange is highly desirable.

From the filled questionnaires the general conclusion can be derived: the European hydrological services do not take sufficient care for the sediment monitoring, and absolutely insufficient regarding bed load and bed material monitoring partially due to financial restrictions. This is surprising because sediment can reduce considerably the transport capacities of rivers and the capacity to store water in reservoirs and lakes. On the other hand suspended load is an important carrier of contaminants soil erosion and sediment transport are among the greatest problems in river management urging better land management.

WMO Manual on Sediment Transport covers several aspects of the sediment monitoring, however they are often disregarded while operating sediment monitoring networks. It would be useful:

(a) to organize post-graduate training courses on the sediment monitoring
(b) to establish an international data bank on sediment measurement
(c) to consider the development of sediment data bank, within the HYCOS system
(d) to encourage national hydrological services to launch national and regional projects on sediment monitoring
(e) to disseminate the report among the Region-VI. countries in order to support joint monitoring of sediment and discharge
(f) to promote unified development in shared river basins, particularly on the Danube, considering the experiences on the Rhine
(g) to request international assistance for the development of the sediment-monitoring networks, and to ensure a sufficient system mainly on the waterways.

10. Acknowledgement

The Rapporteur (Ms. Zs. Buzás) and her associated experts (L. Rákóczi and Ö. Starosolszky) express their appreciation to the sediment experts of Region VI. who submitted the filled questionnaires and offered assistance in the finalization of this report.

11. References

Regional Co-operation of Danube countries: Suspended Sediment and Bed Load Regime of R. Danube (in German and in Russian). Budapest, *1993.*

The monograph collects and analyses the sediment data series contributed by the Danube countries concerning the period 1956-1985. The results reflect the changes of sediment regime of the Danube and its tributaries due to various human impacts during this 30-year interval.

N.E.M. Asselman: Suspended sediment in the river Rhine. Nederlandse Geografische Studies 234. Utrecht,1997.

The study deals with the impact of climate change on erosion, transport and deposition of suspended sediment and with the measurement thereof.

B. Minarik, Zs. Buzas and M. Spreafico: Technical Report to the Regional Association for Europe: Sediment Transport. September, 1997.

The report surveys the instruments and methods applied for the monitoring of sediment transport by various countries sharing the Rhine and the Danube rivers, respectively. The results coincide well with the contents of the present questionnaire.

Forum of the Danubian Hydrological Services: Quality assurance in the context of coordinating the acquisition, evaluation and archiving of quantitative hydrological data. January, 1999.

From among the four main chapters of the study, one is devoted to the solid-matter transport. Ten Danubian countries responded to the questionnaire concentrating on aspects of sediment data collection rather different from the present one.

L. Yuquian: Manual on Operational Methods fog the Measurement of Sediment Transport. WMO Operational Hydrological Reports No.29. WMGI - No. 686. Geneva, 1989.

The handbook provides a comprehensive overview on the various instruments, methods of field measurements and/or sampling of sediment transport and the laboratory processing practices. The rich experiences of the author gained in China supports his useful statements and practical recommendations concerning this important subject.

WMO: Guide to Hydrological Practices. (Geneva, 1981. Volume I. Fourth edition. WMO-No. 168.

Data acquisition and processing are described. Short note on measurement of suspended sediment and bead-load discharges is summarized. Guidance on network density is also recommended.

Lawa-Arbeits Kreis: Fliesgewässer der Bundesrepublik Deutschland Schwebstoffuntersuchungen, Bestandsaufnahme, Stand, 1996.
Sediment Monitoring in the Federal Republic Germany. State of Art in 1996. Description of the monitoring stations and the sampling methods, 1996.

Spreafico, M. et al.: Feststoffbeobachtung im Rhein. Internationale Kommission für die Hydrologie des Rheingebietes. Bericht Nr. II.-11 der KHR, 1996.

The main objective of the project are collecting and judging all operational methods of sediment observation used in riparian countries and comparing models for sediment transport calculations. Summary of methods in Switzerland, Germany and the Netherlands.

Hidrometeoroloski Zavod, Republika Slovenija: The 1997 Hydrological Annuals of Slovenia, Letnik 8, Ljubljana, 1999.

The Hydrological Yearbook contains monthly and annual mean concentrations of suspended material with extremes and of mean quantities of transported material with extremes.

US Geological Survey: Field methods for measurement of fluvial sediment Book 3. Applications of Hydraulics. Chapter C2, Reston, Virginia 1999.

Description of equipment and procedures for collection and measurement of fluvial sediment in the USA. Sediment-sampling equipment and sediment-sampling techniques applied for the suspended-sediment, bed load and bed material are introduced.

Budapest, February 2002.

Table 1

Sediment Monitoring
NETWORK STATISTICS (Region VI)

		Date of introduction			Length of period			Stations (99)			Frequency			Cost	Standardization			Int. co-operation		
		SS	BL	BM	SS	BL	BM	SS	BL	BM	SS	BL	BM	1000 US	SS	BL	BM	SS	BL	BM
1.	Albania																			
2.	Armenia	46	46	46	48	48	48	47	28	28	10-20	10-20	10-20	50	-	-	-	-	-	-
3.	Austria	34	99	-	65	1	-	20	1	-	54	-	-	-	x	-	-	-	-	-
4.	Azerbaijan	0	-	0	30	-	30	46	-	46	12-15	-	2	-	x	-	x	-	-	-
5.	Belorus																			
6.	Belgium	no sediment monitoring																		
7.	Bosnia-Herzegovina																			
8.	Bulgaria	51			49			106			25-60									
9.	Croatia																			
10.	Cyprus																			
11.	Czech Republic	99	-	99	1	-	1	20	-	20	12	-	2	88	x	-	-	-	-	-
12.	Denmark																			
13.	Estonia	78	-	-	22	-	-	2	-	-	12	-	-	-	x	-	-	no	-	-
14.	Finland	62	-	-	28	-	-	85	-	-	4-12	-	-	8	x	-	-	x	-	-
15.	France	69	-	-	31	-	-	1540	-	-	12	-	-	-	x	-	-	-	-	-
16.	Georgia																			
17.	Germany*	65	80	76	35	20	24	69	65	-	365	1106		?	x	x	x	x	x	-
18.	Greece																			
19.	Hungary	52	52	-	48	22	-	25	4	4	5-10	1-3	1-3	81	x	-	-	x	-	-
20.	Iceland	63	-	-	37	-	-	25	-	-	6-12	-	-	88	x	-	-	x	-	-
21.	Ireland	no sediment monitoring							-			-		-	-	-	-	-	-	-
22.	Israel																			
23.	Italy																			
24.	Jordan																			
25.	Kazahstan																			
26.	Latvia	65	75	76	35	25	24	5	1	1	35-20	3-5	3-5	3,3	x	x	x	x	x	x
27.	Lebanon																			
28.	Lithuania	69	-	-	34	-	-	3	-	-	6-10	-	-	2,8	x	-	-	-	-	-
29.	Luxembourg																			
30.	Macedonia	61	-	-	38	-	-	18	-	-	365	-	-	9,8	x	-	-	no	-	-

		Date of introduction			Length of period			Stations (99)			Frequency			Cost	Standardization			Int. co-operation		
		SS	BL	BM	SS	BL	BM	SS	BL	BM	SS	BL	BM	1000 US	SS	BL	BM	SS	BL	BM
31.	Malta																			
32.	Moldova	57	76	-	42	23	-	20	1	-	4-12	1-2	-	25	x	x	-	-	-	-
33.	Monaco																			
34.	Netherlands	80	80	51	20	20	50	-	-	-	-	-	-	177	x	x	x	x	x	-
35.	Norway	68	68	-	32	32	-	14	3	-	120-365	20-50	-	135	x	-	-	-	-	-
36.	Poland	37	-	-	53	-	-	14	0	0	8	-	-	5	x	-	-	-	-	-
37.	Portugal	78	-	78	16	-	12	0	0	0	5-10	-	4-8	-	x	-	x	-	-	-
38.	Romania	60	70	70	39	22	29	478	15	65	25-30	3-6	2-4	-	x	x	x	-	-	-
39.	Russia	36	-	36	63	-	63	725	-	230	365	-	-	-	x	-	x	x	-	x
40.	Slovakia	92	-	-	8	-	-	25	-	-	365	-	-	10(?)	-	-	-	x	-	-
41.	Slovenia	55	-	-	44	-	-	6-11	-	-	4-8	-	-	30	x	x	x	-	-	-
42.	Spain																			
43.	Sweden	65	-	-	35	-	-	46	-	-	-	-	-	-	x	-	-	-	-	-
44.	Switzerland	62	89	89	38	11	11	86	80	80	104	-	-	36	x	x	x	x	x	-
45.	Syria																			
46.	Turkey	62	-	-	38	-	-	195	-	-	5-12	-	-	130	x	-	-	-	-	-
47.	Ukraine	32	32	-	67	67	-	115	119	-	6-12	1-2	-	-	x	x	-	-	-	-
48.	UK																			
49.	Yugoslavia	60	-	-	40	-	-	28	-	-	4-6	-	-	15	x	-	-	x	-	-
Germany (Lands) addition																				
Baden Würtenberg		97	-	-	2	-	-	18	-	-	36	-	-	-	x	-	-	x	-	-
Saarland		94	-	-	6	-	-	2	-	-	6-12	-	-	-	x	-	-	x	-	-
Mecklenburg/Vorpomer		96	-	-	5	-	-	12	-	-	6-12	-	-	-	-	-	-	-	-	-
Brandenburg		98	-	-	2	-	-	4	-	-	6-10	-	-	-	x	-	-	-	-	-
Sachsen-Anhalt		94	-	94	6	-	6	4	-	31	12	-	1	-	-	-	-	-	-	
Thüringen		98	-	-	-	-	-	64	-	-	2	-	-	167	x	-	-	-	-	-
Bayern		23	-	-	76	-	-	-	-	-	-	-	-	-	x	-	-	x	-	-

*Central Service

Table 2

Sediment Monitoring
EVALUATION OF SAMPLINGS AND PROCESSING

		SS sampling	BL sampling	BM sampling	Processing	Remarks
1.	Albania					
2.	Armenia	-				
3.	Austria	milk bottle; turbidity	ultrasonic; monitor		filtering, drying	
4.	Azerbaijan	Delft bottle; pumping	-	disturbed	filtering, drying	WQ jointly
5.	Belorus					
6.	Belgium					
7.	Bosnia-Herzegovina					
8.	Bulgaria					
9.	Croatia					
10.	Cyprus					
11.	Czech Republic	other		scraping	filtering, drying	WQ, SS, BM all together
12.	Denmark					
13.	Estonia	milk bottle, pump/filtration			filtering, drying	
14.	Finland	other: Ruttner s., filtration			filtering	WQ jointly
15.	France	milk bottle, turbidity			filtering	
16.	Georgia					
17.	Germany*	pump/filter bucket	video, tracing bedload sampler	scraping, grab boring	filter, drying	
18.	Greece					
19.	Hungary	milk bottle, pumping	video, tracer sampler, hydrophone	scraping (harang)	drying	
20.	Iceland	milk bottle			filter/drying sedigraph	WQ jointly
21.	Ireland					
22.	Israel					
23.	Italy					
24.	Jordan					
25.	Kazahstan					
26.	Latvia	Delft bottle	sampler	disturbed (scraping)	drying	in 1999 stopped, WQ jointly
27.	Lebanon					
28.	Lithuania	milk bottle, pump/filter			filterint/drying	
29.	Luxembourg					
30.	Macedonia	bucket, plastic, bathometer	bin		filtering/drying	

		SS sampling	BL sampling	BM sampling	Processing	Remarks
31.	Malta					
32.	Moldova	milk bottle, other	other		filtering, drying	
33.	Monaco	turbidimetry.	trap, echo-sounder	grabs	settling tube	
34.	Netherlands					
35.	Norway	ISCO samplers	bed load samplers	grabs, scraping	filtering, drying, ignition, laser coulter	SS jointly WQ, BL jointly WQ
36.	Poland	milk bottle			filtering, drying	
37.	Portugal	Delft bottle		grabs	filtering	
38.	Romania	milk bottle	settler, trap	grabs, scraping core sampling	filtering, drying	
39.	Russia	Delft bottle, pumping, special	special device	undisturbed, boring	filtering, drying	
40.	Slovakia	Delft bottle			filtering, drying	
41.	Slovenia	milk bottle, turbidimetry			filtering, drying	
42.	Spain					
43.	Sweden	Ruttner sample			filtering	combined monitoring
44.	Switzerland	Swiss bottle, turbidity	trap, hydrophone	seraping, line probe		WQ jointly
45.	Syria					
45.	Macedonia					
46.	Turkey	milk bottle			filtering, drying	
47.	Ukraine	milk bottle, pump/filter			filtering, drying	
48.	UK					
49.	Yugoslavia	vacuum, bathometer		scraping, boring	filtering	
Germany (Lands) addition						
Baden Würtenberg		pump/filter			filtering	WQ jointly
Saarland		other			drying	
Mecklenburg/Vorpomer		centrifuge (50-60 l)				
Brandenburg		pump/filter				WQ jointly
Sachsen-Anhalt		pumping		scraping	drying	
Thüringen		pump/filtering			filtering, drying	
Bayern		other			filtering	WQ jointly

*Central Service

Table 3

DENSITY OF SUSPENDED SEDIMENT MONITORING NETWORK

Country	Area, km^2	Station	Density km^2/station
Armenia	29 800	-	-
Austria	83 856	20	4 192
Azerbaijan	86 600	46	4 330
Belgium	30 519	0	0
Bulgaria	110 993	106	1 047
Czech Republic	78 864	20	3 893
Estonia	45 100	2	22 750
Finland	338 145	85	3 978
France	551 700	1 540	358
Germany (Federal network)*	349 520	69	5 065
Hungary	93 030	25	3 721
Iceland	103 000	25	4 120
Ireland	70 283	0	0
Latvia	64 600	5	12 420
Lithuania	65 200	3	21 733
Macedonia (FYR)	25 715	18	1 428
Moldova	33 700	20	1 685
The Netherlands	41 548	-	-
Norway	323 878	14	23 134
Poland	312 683	14	22 334
Portugal	92 389	0	0
Romania	237 500	478	496
Russia	17 075 40	725	23 552
Slovakia	49 007	25	1 960
Slovenia	20 251	11	1 841
Sweden	449 464	46	9 782
Switzerland	41 293	86	480
Turkey	779 452	195	3 997
Yugoslavia	102 173	28	3 649

* Germany	349 520	104	3 360
(Provincies, in addition)		173	2 020

Monitoring Sediment Transport
Instructions for the filling of the Questionnaire

In the replies, there are indications (yes or no), and estimations (numerical values). The reply depends on the type of the question.

In the first five lines, the basic information on the reply should be given.

1. In par 1. the indication of three basic monitoring items are given about the three major types of sediment related monitoring.
   The date of starting the monitoring, and the length of the observation period should be given in calendar year. There can be missing periods, when observations were not continously carried out.

2. The total number of from/or the monitoring stations should be given.
   The annual frequency means the days of the effective samplings per year per station (e.g. 12). If there are different values, please indicate.
   The main types of the sampling/monitoring are given considering the simultaneous measurements.
   The distribution of the sampling points for suspended sediment and bed load is characterized whether samples are taken near the surface of water, or along the verticals.

3. The average number of the sampling points are estimated.
   The character of the evaluation of the samplings are only indicated.

4. The mean error can be estimated for suspended sediment and for bed load.

5. The reply is whether transport rate is, or is not calculated. I the answer is yes, daily, monthly and/or annual values are given.

6. The instruments used for sampling (measurement) can be indicated.

7. It should be indicated if national or international standards are used.

8. The data processed in different forms can be indicated.

9. The data stored in different forms can be indicated.

10. The annual costs (expenditures) of the whole monitoring items should be indicated in US dollars.

11. The share of sediment monitoring, total costs of sediment monitoring within the costs of the hydrological service (annual budget) are estimated, and expressed in per-cent.

12. The manpower engaged with monitoring can be given in man-days.

13. The international co-operations related sediment monitoring can be indicated with special regard to neighbour countries.

14. Demands and utilization of data are interesting for the future plans. Please give some information about them.

Note: If you have more detailed information, please do not hesitate to attach with the appropriate report.

WMO, Region VI
WGH – Monitoring Sediment Transport
Questionnaire
(to be filled and returned before 15 February 2000)

Country:
Service:
Responsible person (name):
Mailing address:
Date of the reply:

1. Status of the Sediment Monitoring Network

Monitoring Network in 1999

Suspended sediment ☐

Date of the introduction of monitoring, year	☐☐☐☐			
Length of the period of monitoring, years	☐☐☐			
Length of the missing periods if any	☐☐☐☐ from	☐☐☐☐ to	☐☐☐☐ from	☐☐☐☐ to

Bed load ☐

Date of the introduction of monitoring, year	☐☐☐☐			
Length of the period of monitoring, years	☐☐☐			
Length of the missing periods if any	☐☐☐☐ from	☐☐☐☐ to	☐☐☐☐ from	☐☐☐☐ to

Bed material ☐

Date of the introduction of monitoring, year	☐☐☐☐			
Length of the period of monitoring, years	☐☐☐			
Length of the missing periods if any	☐☐☐☐ from	☐☐☐☐ to	☐☐☐☐ from	☐☐☐☐ to

2. Station statistics
2.a Stations and monitoring frequency

Number of stations operated in 1999	Suspended sediment	☐☐☐
	Bed load	☐☐☐
	Bed material	☐☐☐
Average annual frequency of sampling	Suspended sediment	☐☐ - ☐☐
	Bed load	☐☐ - ☐☐
	Bed material	☐☐ - ☐☐

Is the sampling dependent on the hydrological situation?	Suspended sediment	☐ Yes	☐ No
	Bed load	☐ Yes	☐ No
	Bed material	☐ Yes	☐ No

2.b The methods of the measurement

Suspended sediment sampling separately (without discharge measurement)	☐
In the monitoring jointly suspended sediment and water quality	☐
In the monitoring jointly suspended sediment and discharge	☐
Combined monitoring (suspended sediment, water quality, discharge)	☐
Bed load separately	☐
Jointly bed load and discharge	☐
Bed load with suspended sediment	☐

Where are the suspended sediment sampling points in the cross section:

surface	☐
verticals	☐

3. Sampling points

		Suspended sediment	Bed load
Average number of sampling points	within the vertical	☐☐	☐☐
	number of verticals	☐☐	☐☐
	within the width	☐☐	☐☐
	within the cross-section	☐☐	☐☐
	total points in cross section	☐☐	☐☐
Points of the samplings	selective point sampling	☐	☐
	vertical mean samples	☐	☐
	cross section mean samples	☐	☐

4. Mean relative error, %

Accuracy of the suspended sampling – individual	points	☐☐
	verticals	☐☐
	cross section	☐☐

5. Suspended sediment and bed load transport rate calculation

	Suspended load	Bed load
Cross sectional transport rate calculation	☐	☐
Daily	☐	☐
Monthly	☐	☐
Annual	☐	☐

6. Instruments and evaluation

Method of suspended load sampling

Delft bottle	☐	pumping	☐
Milk bottle	☐	pumping/filtering	☐
turbidity meter	☐	other	☐

Method of bed load sampling

ultrasonic monitor	☐	settler	☐
video camera	☐	bed load trap	☐
traced sediment	☐	echo-sounder (for dunes)	☐
dunes measurement	☐	other	☐

Method of sampling bed material

			grabs		☐
disturbed	☐	other	☐	scraping	☐
undisturbed (boring)	☐	core sampling (boring)			☐

Evaluation of suspended sediment samples

filtering	☐
drying	☐
other	☐

7. Standardization

	National standards	International standards
Suspended sediment	☐	☐
Bed load	☐	☐
Bed material	☐	☐

Specification ……...
……

8. Data Processing

	Concentration	Grain size distribution	Sampled mass or weigth
Suspended sediment			-
Bed load	-		
Bed material	-		-

9. Data storage

	measured data	processed time series	monthly data	annual data	archive	data bank (computerized)
Suspended sediment	☐	☐	☐	☐	☐	☐
Bed load	☐	☐	☐	☐	☐	☐
Bed material	☐	☐	☐	☐	☐	☐

10. Estimated annual costs (US$)

	Field work	Laboratory	Processing and storage	∑/year
Suspended sediment				
Bed load				
Bed material				
TOTAL				

11. Share of sediment in the total cost

Annual budget of the hydrological service in 1000 US$ (a) ☐☐☐☐

Annual budget of the monitoring sediments in 1000 US$ (b) ☐☐☐☐

Ratio, b/a ☐☐%

12. Manpower (for field work)

	Working days
Suspended sediment	
Bed load	
Bed material	
TOTAL	

13. International co-operation

	Suspended sediment	Bed load	Bed material
Data exchange	☐	☐	☐
Joint measurement	☐	☐	☐

Number of joint stations	☐☐☐	☐☐☐	☐☐☐
Joint study	☐	☐	☐

14. Future plans

Development of network, instrumentation, frequency, data evaluation (in few sentencies)

Date:

Signature