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Analysis of the quality of suspended sediment data

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Abstract For inhomogeneous river conditions, the practice of excluding statistical outliers from the calculation of cross-sectional mean suspended load concentrations may introduce significant error (due to elimination of components of the group mean) instead of the intended improvement in data quality. In this study the examination of outliers (samples) of inhomogeneous river reaches or cross sections is proposed with regard to compatibility of operational procedure and flow conditions, ***before*** deciding on the elimination of such samples; following this procedure the representative character of mean concentration values would be maintained and quality could be improved. In the example presented (30 suspended load measurements at the Indaial sediment gauging station on the River Itajaí-Açu in southern Brazil) an improvement in the quality of mean concentration values is observed, after elimination of defective samples.

Analyse de la qualité de données de charges en suspension

Résumé Lorsque les conditions d'écoulement d'une rivière ne sont pas homogènes, il est courant d'éliminer les valeurs statistiquement suspectes du calcul de la concentration moyenne en suspension. Au lieu d'améliorer la qualité des données, cette pratique peut introduire des erreurs significatives découlant de l'omission de composantes déterminantes de la moyenne de groupe. Cette étude propose de vérifier si les échantillons collectés dans une section transversale, ou un bief, où l'écoulement n'est pas homogène, sont compatibles avec les procédures opérationnelles mises en oeuvre et les conditions de l'écoulement, ***avant*** de décider de l'élimination de certains échantillons. Ainsi faisant la représentativité des concentrations moyennes obtenues peut être garantie et la qualité des données améliorée. Pour l'exemple choisi (30 mesures de suspension au poste sédimentométrique d'Indaial, sur la rivière Itajaí-Açu dans le sud du Brésil) on observe une nette amélioration de la qualité des valeurs de la concentration moyenne si l'on choisit les échantillons selon la méthode préconisée.

VARIANCE OF INDIVIDUAL COMPONENTS IN A GROUP MEAN

In this paper, the quality of fluvial sediment data, such as suspended sediment discharge and concentration (involving suspended bed material and wash load) is assessed by the proximity of measured to real values. Guy's (1968) method for assessing the quality of such data, consisting of an analysis of the deviation of individual components from a group mean, can be considered an efficient measure when applied to river reaches and cross sections where flow velocities, depths, form of cross section, bed material composition, bed forms and other parameters can be considered homogeneous. However, in rivers where conditions are not homogeneous, the direct application of Guy's procedure may yield inconclusive results, as different factors contribute to wide scatter of data. The concentration values of suspended sediment of individual samples with regard to the mean of the cross section constitute an example of this point.

Consulting national and international standards and data processing procedures (e.g. Brazil, 1967; Canada, 1979; ISO, 1977; Vanoni, 1977) it is noted that, for the sites selected as permanent sediment monitoring stations, upstream and cross-stream conditions are assumed to be homogeneous. Where river conditions are inhomogeneous, the principal factors contributing to the deviation of individual samples from their mean should be identified. Such factors refer to operational error, instrument inadequacy as pointed out by van Rijn & Schaafsma (1986), and local variations in the sediment transport/supply process.

An analysis of the quality of sediment concentration data should be compatible — in terms of computational effort — with the improvement of data and should therefore begin by investigating the operational conditions of the sampling programme. The examination of data scatter due to inhomogeneous river- and sediment-transport conditions constitutes a separate phase and would depend on the result of the measurement consistency analysis and other aspects.

This paper presents as example of the analysis, together with the possible improvement in the quality of data on mean concentration of suspended sediment at the Indaial sediment gauging station on the River Itajaí Açu.

EXAMINATION OF OPERATIONAL CONDITIONS

Original field and laboratory records of the River Itajaí-Açu at the Indaial gauging station (Santa Catarina, Brazil, Fig. 1) were furnished by ELETROBRAS as part of a general study on sediment problems in Brazilian rivers (Bordas *et al.*, 1988).

At the site of the gauging station, irregularities in cross section and considerable variation of sediment composition have been observed. The data on river conditions examined in this study include the flow velocities at 9–15 equidistant verticals for 30 measurements of suspended sediment discharge, executed during the period of 1976–1984. During each measurement, a set of single samples was collected by the equal transit rate method. Each sample

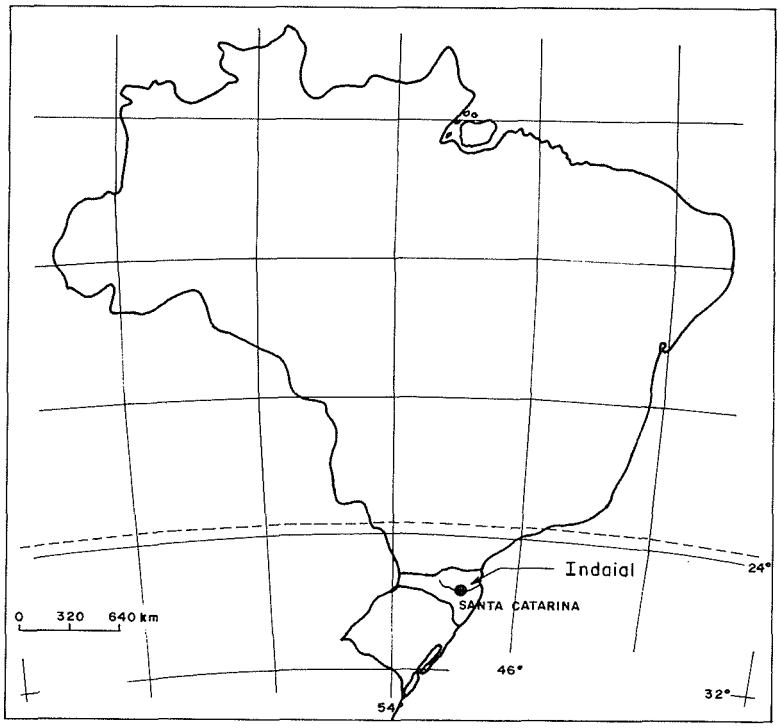

Fig. 1 *Site of the Indaial sediment gauging station.*

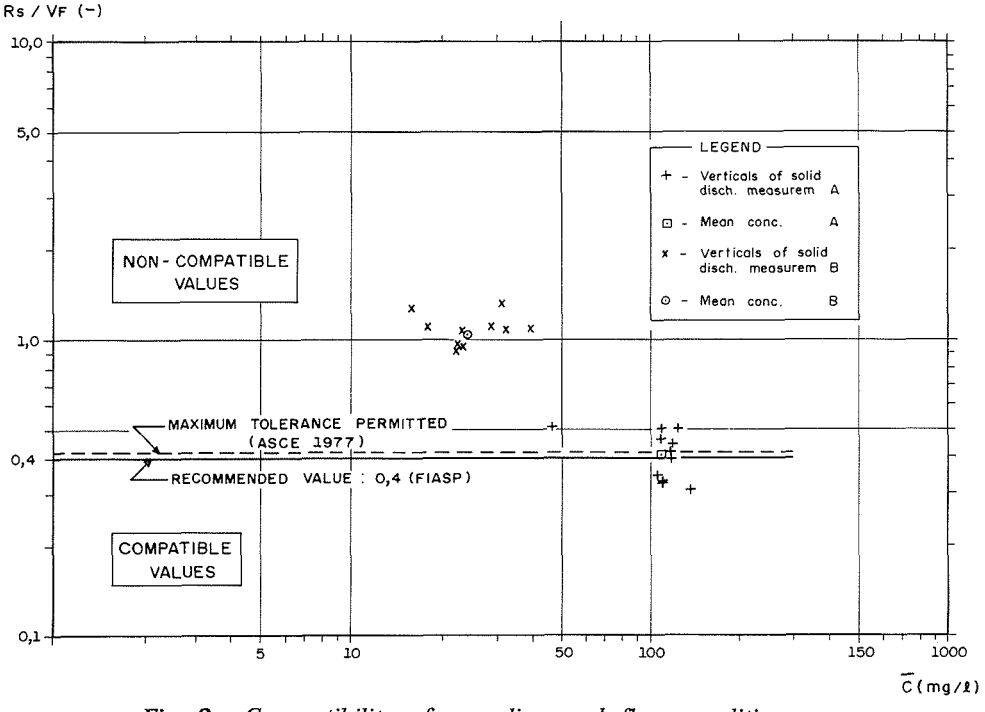

Fig. 2 *Compatibility of sampling and flow conditions.*

was processed separately.

During the data analysis, field records and calculated values of field operations were compared. For that purpose it was necessary to examine mean flow velocity in the verticals, sample volume, velocity profile, and rate of instrument transit. Individual samples were classified as defective when field notes showed significant discrepancies from recommended procedures (or values) for at least two of the above items. All samples resulting from defect operational procedures show significant deviation from the mean concentration value of the cross section.

The sampling of water-sediment mixtures in streams is strongly affected by the alteration of the sample intake velocity with regard to velocities in the undisturbed stream flow (FIASP, 1941, for USH, D and P series). When rates for lowering and raising instruments are not those that are recommended, water-sediment concentration in samples may be significantly in error. Therefore, the use of a single parameter in the verification procedure of operational conditions was tested. The parameter selected for this purpose was the relation R_s/V_f, where R_s represents the instrument transit rate and V_f mean flow velocity of the sampled vertical. As the samples identified as defective by the parameter R_s/V_f coincided in all cases with those resulting from the use of various other parameters, as described earlier, preference was given to use of the R_s/V_f relation (see Fig. 2).

IMPROVEMENT IN DATA QUALITY

Table 1 shows the effect on mean concentration values of eliminating defective samples or groups of samples from the estimate of mean concentration. Using Guy's method, e_1 and e_2 represent the percentage of error at the 90% level of significance for the preliminary (c_1) and final estimates (c_2) of the mean suspended sediment concentration in a cross section, as obtained in a multivertical sampling programme.

Table 1 *Mean concentration of suspended sediment*

Number of measurements (month/year)	*Mean concentration** c_1 *(mg l^{-1})*	*Number of vertical samples** n_1	*Error (%) at level of significance* S = 90%* e_1
6 (11/78)	*21.0*	*13*	*51*
7 (05/78)	*35.2*	*15*	*40*
25 (10/83)	*104.2*	*12*	*23*
Number of measurements (month/year)	*Mean concentration*** c_2 *(mg l^{-1})*	*Number of vertical samples*** n_2	*Error (%) at level of significance** S = 90%* e_2
6 (11/78)	*15.2*	*11*	*12*
7 (05/78)	*24.7*	*11*	*17*
25 (10/83)	*83.2*	*10*	*6*

**Without excluding defective samples.* ***After excluding defective samples.*

Adopting the relative value of 100 for e_1, representing the error (%) of the preliminary estimate of mean concentration c_1, in the present example a reduction of error was obtained for e_2 to 23.5; 42.5 and 26.1 by eliminating operationally defect samples from data used in the calculation of the mean concentration values c_2.

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