STUDY OF THE NORMALITY AND HOMOGENEITY OF LEVELLING ERRORS (SUMMARY)

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(1) Most statistical methods of analysis suggested for use in levelling are based on the normal law. To test the normality of the actual distribution of, say, the aggregate of the values of $w_{ij} = \rho_{ij}/R_{ij}$ the four moments μ_1, μ_2, μ_3 and μ_4 are calculated from the equations

$\mu_1 = 0, \mu_2 = v_2 - v_1^2, \mu_3 = v_3 - 3v_1v_2, \mu_4 = v_4 - 4v_1v_3 + 6v_1^2v_2 - 3v_1^4$, where $v_r = \sum w_{ij}^r/N$, N being the number of w_{ij} 's. For large N , the asymmetry of the distribution and its kurtosis may be assessed from the values of $\gamma_1 = \mu_3/\mu_2^{3/2}$ and $\gamma_2 = \beta_2 - 3 = (\mu_4/\mu_2^2) - 3$, with standard errors (s.e.) $\sqrt{(6/N)}$ and $\sqrt{(24/N)}$ respectively. Sharply peaked long-tailed curves have $\beta_2 > 3$ and are called leptokurtic, comparison being made with the normal distribution for which $\beta_2 = 3$.

Analysis of the Nile Delta net gave the following: (mark the influence of outlying values!)

N	γ_1	γ_2	s.e. (γ_1)	s.e. (γ_2)	Remarks
1186	0.597	4.249	0.0712	0.1424	Highly asymmetric and leptokurtic.
1178	0.024	0.784	0.0714	0.1427	The isolation of eight outlying positive values symmetrized the distribution and greatly reduced its kurtosis.
1178	0.1128	0.946	0.0714	0.1427	This is the distribution of the deviations of the individual values of w_{ij} from the respective line means.

(2) To test the equality of a set of k variances, the quantity

$$M = N \ln \left[\frac{\sum_{i=1}^k \nu_i S_i^2}{N} \right] - \sum_{i=1}^k (\nu_i \ln S_i^2)$$

where ν_i is the number of degrees of freedom on which the estimation of the variance s_i^2 is based, and $N = \sum_{i=1}^k \nu_i$. M is distributed like χ^2 with $k-1$ degrees of freedom.

The value of M in the Nile Delta net was 257 with 85 degrees of freedom; but when the eight outlying values w_{ij} were isolated M reduced to 186 which remains significant ($M = 131.0$ at 0.1% level).

Weighting w_{ij} in proportion to R_{ij} eliminated this heterogeneity.

The full text of this paper will be published.