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## Application of Difference Analysis Perception in Comparison of Calculation of the Effects of Floods

### 1. Introduction

The theory of direct observations of differences implies that the value was measured independently twice [4]. We can assume the values for the variety of precise observations respectively as:  $p_1$  and  $p_2$ , and the measurement results by  $W$  and  $W_2$ . At the same time  $W_2$  will mean a valuation carried out by experts representing a given municipality, and  $W$  the valuation is made by a committee representing the Treasury in the person of the Governor. The difference observations  $\Delta w$  can be written as:

$$\Delta w = W_2 - W, \text{ that is } W_2 = W + \Delta w \quad (1)$$

The weighted average will therefore:

$$x = \frac{p_1 \cdot W + p_2 \cdot (W + \Delta w)}{p_1 + p_2} = W + \frac{p_2}{p_1 + p_2} \cdot \Delta w \quad (2)$$

Amendments  $V_1$  and  $V_2$  take the values:

$$V_1 = x - W = W + \frac{p_2}{p_1 + p_2} \cdot \Delta w - W = \frac{p_2}{p_1 + p_2} \cdot \Delta w \quad (3)$$

$$V_2 = x - W - \Delta w = W + \frac{p_2}{p_1 + p_2} \cdot \Delta w - W - \Delta w = \frac{1 - p_2}{p_1 + p_2} \cdot \Delta w = -\frac{p_1}{p_1 + p_2} \cdot \Delta w \quad (4)$$

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The value  $V_1 : V_2$  takes respectively:

$$V_1 : V_2 = -p_2 : p_1 = -\frac{1}{p_1} : \frac{1}{p_2} \quad (5)$$

While calculating the amendments, the increase  $\Delta w$  is split between the observations in proportion to the weight  $p_1$  and  $p_2$ .

The average error unit can therefore be calculated from the formula:

$$m_0 = \sqrt{\frac{p_1 \cdot V_1^2 + p_2 \cdot V_2^2}{2-1}} \quad (6)$$

The arithmetic mean of the average error can be calculated from the formula:

$$m_x = \frac{m_0}{\sqrt{p_1 + p_2}} \quad (7)$$

For equally accurate observations, namely those for which the models shown above can be written respectively:

$$x = \frac{W + (W + \Delta w)}{1+1} = W + \frac{1}{2} \cdot \Delta w \quad (8)$$

$$V_1 = x - W = W - W + \frac{1}{2} \cdot \Delta w = \frac{1}{2} \cdot \Delta w \quad (9)$$

$$V_2 = x - W - \Delta w = W + \frac{1}{2} \cdot \Delta w - W - \Delta w = -\frac{1}{2} \cdot \Delta w \quad (10)$$

$$m_0 = \sqrt{\frac{V_1^2 + V_2^2}{2-1}} = \sqrt{\left(\frac{1}{2} \cdot \Delta w\right)^2 + \left(-\frac{1}{2} \cdot \Delta w\right)^2} = \frac{\Delta w}{\sqrt{2}} \quad (11)$$

$$m_x = \frac{m_0}{\sqrt{2}} = \frac{\Delta w}{2} \quad (12)$$

These formulas are applicable only for the observations burdened with only random errors. In the data presented in this work there is a strong systematical factor. It can be *a priori* assumed that the valuation done for the community will be fraught with a tendency to overestimate, yet the valuations done for the Governor will have a contrary tendency.

## 2. Comparison of Pairs of Observations to Estimate the Effects of Floods

The author examined 142 pairs of valuations in Podkarpackie made by different people from the government for the purpose of flood damage estimates. All valuations related to flood damage in May and June 2010. Because of the slight timing differences in the valuation, the influences of the real estate market environment were completely omitted [1–3]. A preliminary analysis of the character values  $\Delta w$  are presented in table 1. An even distribution of characters  $\Delta w$  and the sum of  $\Delta w$  close to zero, is a prerequisite for an absence of systematic errors. Deviations from the above-mentioned principles may be evidence of the systematic errors of observation order.

**Table 1.** Statement of Marks (signum) values for pairs of observations analyzed

| $\Delta w$                | $\Delta w < 0$ | $\Delta w = 0$ | $\Delta w > 0$ |
|---------------------------|----------------|----------------|----------------|
| Number of cases           | 3              | 34             | 105            |
| Percentage $\Delta w$ [%] | 2              | 24             | 74             |

Results of trade test values in table 1 shows that the data set is marred by a systematic factor, which we call a “strong tendency of self-government to overestimate the effects of flooding”.

Accordingly, in the statistical analysis we calculated the factor of systematic and fundamental statistics by the formulas:

$$\mu = \frac{\sum_{i=1}^n \Delta w}{n} \quad (13)$$

$$m_{\Delta w} = \sqrt{\frac{\sum_{i=1}^n p(\Delta w - \mu)^2}{n-1}} \quad (14)$$

$$m_0 = \sqrt{\frac{\sum_{i=1}^n p(\Delta w - \mu)^2}{2(n-1)}} \quad (15)$$

$$m_x = \frac{1}{2} \sqrt{\frac{\sum_{i=1}^n p(\Delta w - \mu)^2}{n-1}} \quad (16)$$

and after inserting the data we obtained the following results:

$$\mu = 2\,530\,583 \text{ PLN}$$

$$m_{\Delta w} = 6\,986\,240 \text{ PLN}$$

$$m_0 = 4\,940\,018 \text{ PLN}$$

$$m_x = 3\,493\,120 \text{ PLN}$$

Even taking into account the total value of the estimated loss of 1 076 075 352 PLN for 142 local governments, the above statistics may be questionable as to its credibility because of the large variation of the estimated amounts of flood damage. Consequently, the lists were ranked according to the amount of value and the results in two tables of twenty local authorities following the criterion of the estimated losses.

**Table 2.** Balance sheet of twenty lowest sums of estimated flood losses in the Podkarpackie Province

| No. | Commune/Powiat         | $W_2$ – estimation done by the local government | $W$ – estimation done by Main Office of the Podkarpackie Province | $\Delta w = W_2 - W$ | $\Delta w / W_2 \cdot 100$ [%] |
|-----|------------------------|---|---|----------------------|--------------------------------|
| 1   | UM Łańcut              | 91 600  | 91 600  | 0                    | 0                              |
| 2   | UG Majdan Królewski    | 107 000   | 72 000  | 35 000               | 33                             |
| 3   | UG Trzebownisko        | 122 000   | 122 000   | 0                    | 0                              |
| 4   | UG Radymno             | 135 000   | 135 000   | 0                    | 0                              |
| 5   | UG Pawłosiów           | 137 200   | 137 200   | 0                    | 0                              |
| 6   | UG Jarosław            | 196 500   | 196 500   | 0                    | 0                              |
| 7   | UG Przemyśl            | 212 100   | 212 100   | 0                    | 0                              |
| 8   | UMiG Ustrzyki Dolne    | 278 276   | 241 576   | 36 700               | 13                             |
| 9   | UG Czarna              | 305 000   | 275 000   | 30 000               | 10                             |
| 10  | UMiG Rudnik            | 325 000   | 325 000   | 0                    | 0                              |
| 11  | UG Lubaczów            | 332 102   | 285 000   | 47 102               | 14                             |
| 12  | UMiG Głogów Małopolski | 336 000   | 336 000   | 0                    | 0                              |
| 13  | UG Dzikowiec           | 360 000   | 360 000   | 0                    | 0                              |
| 14  | UG Pysznica            | 389 508   | 389 508   | 0                    | 0                              |
| 15  | UG Krzeszów            | 409 840   | 409 840   | 0                    | 0                              |
| 16  | UG Niwiska             | 442 000   | 317 000   | 125 000              | 28                             |
| 17  | UG Łańcut              | 481 600   | 481 600   | 0                    | 0                              |
| 18  | UG Besko               | 500 000   | 400 000   | 100 000              | 20                             |
| 19  | UG Dubiecko            | 540 000   | 540 000   | 0                    | 0                              |
| 20  | UG Tyrawa Wołoska      | 616 500   | 494 000   | 122 500              | 20                             |

Source: own study based on data of The Main Office of the Podkarpackie Province in Rzeszów

The results presented in the table 2 show a big conformity of both valuations. Only in the case of one valuation among twenty analysed ones, the discrepancy between valuations exceeded 30%. The discrepancy over 20% between researched valuations was noted only in four cases in twenty analysed ones. In as many as 13 cases the conformity of both valuations was identical which proves the big credibility of prepared valuations. The basic statistics for the data contained in the table 2 are presented below:

$$\mu = \frac{\sum_{i=1}^n \Delta w}{n} = 24\ 815 \text{ PLN}$$

$$m_{\Delta w} = \sqrt{\frac{\sum_{i=1}^n \rho(\Delta w - \mu)^2}{n-1}} = 42\ 305 \text{ PLN}$$

$$m_0 = \sqrt{\frac{\sum_{i=1}^n \rho(\Delta w - \mu)^2}{2(n-1)}} = 29\ 914 \text{ PLN}$$

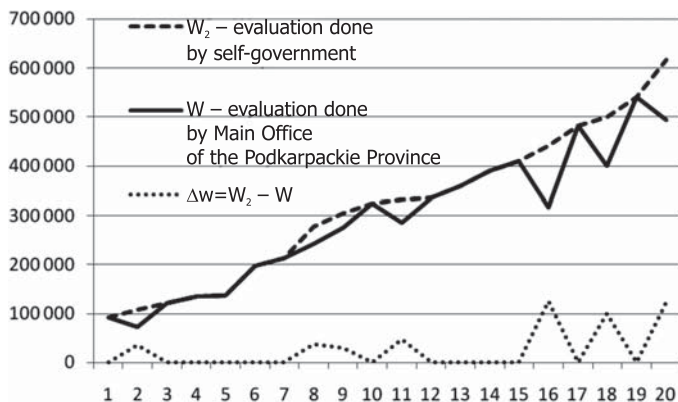
$$m_x = \frac{1}{2} \sqrt{\frac{\sum_{i=1}^n \rho(\Delta w - \mu)^2}{n-1}} = 21\ 152 \text{ PLN}$$

Systematic factor of 13 in 20 cases did not exceed 10% of the value estimated by the local government. It can be claimed that the divergences in the valuations appearing as a result of the presence of the systematic factor slightly distorting the sums of estimated losses, are put within bounds of tolerance and they do not exceed commonly recognised standards. The fact that the value of the systematic factor, if it does not assume the zero value it always is positive irrefutably proves the tendency to overrate the estimated loss or underrating by the staff representing the voivod.

Figure 1 allows to graphically estimate the presented data and it confirms previously formed conclusions.

The data presented in table 3 are slightly different. The table show twenty valuations of flood losses where biggest values of estimated losses were noted.

The data presented in table 3 show great discrepancy between both estimations. Only eight valuations did not exceed the level of 30% difference between two estimations. The greatest discrepancy was 88%, and the smallest 4%. Great value of the systematic factor 14 155 155 PLN makes preparing additional statistics totally useless. The average level of estimation discrepancy exceeds 38%, so it does not meet any standards expected for experts.



**Fig. 1.** Specification of valuations and differences of Floyd results for twenty lowest values of loss (in PLN)

Source: own study based on data of The Main Office of the Podkarpackie Province in Rzeszów

**Table 3.** Balance sheet of twenty highest sums of estimated flood losses in the Podkarpackie Province

| No. | Commune/Powiat           | $W_2$ – estimation done by the local government | $W$ – estimation done by Main Office of the Podkarpackie Province | $\Delta w = W_2 - W$ | $\Delta w / W_2 \cdot 100$ [%] |
|-----|--------------------------|---|---|----------------------|--------------------------------|
| 1   | UMiG Brzostek            | 14 209 010                                      | 7 649 350   | 6 559 660            | 46                             |
| 2   | UG Wielopole S           | 14 743 114                                      | 9 440 000   | 5 303 114            | 36                             |
| 3   | UG Mielec                | 15 589 000                                      | 8 089 000   | 7 500 000            | 48                             |
| 4   | UMiG Pilzno              | 18 678 000                                      | 17 088 009  | 1 589 991            | 9                              |
| 5   | Mielec district          | 19 974 481                                      | 13 080 000  | 6 894 481            | 35                             |
| 6   | UMiG Ropczyce            | 20 098 558                                      | 10 316 920  | 9 781 638            | 49                             |
| 7   | Łańcut district          | 20 272 000                                      | 11 612 000  | 8 660 000            | 43                             |
| 8   | Strzyżów district        | 22 282 000                                      | 15 852 000  | 6 430 000            | 29                             |
| 9   | Sanok district           | 22 751 730                                      | 14 423 500  | 8 328 230            | 37                             |
| 10  | UG Dębica                | 29 485 944                                      | 17 082 500  | 12 403 444           | 42                             |
| 11  | Tarnobrzeg district      | 30 886 117                                      | 22 446 000  | 8 440 117            | 27                             |
| 12  | Krosno district          | 32 172 644                                      | 13 728 000  | 18 444 644           | 57                             |
| 13  | UG Gorzyce               | 32 739 979                                      | 24 051 479  | 8 688 500            | 27                             |
| 14  | Dębica district          | 37 923 180                                      | 33 299 500  | 4 623 680            | 12                             |
| 15  | UM Jasło                 | 39 112 868                                      | 27 401 000  | 11 711 868           | 30                             |
| 16  | UG Frysztak              | 50 542 330                                      | 5 959 800   | 44 582 530           | 88                             |
| 17  | UM Tarnobrzeg            | 52 320 815                                      | 50 270 815  | 2 050 000            | 4                              |
| 18  | Governor of the province | 68 425 640                                      | 29 278 700  | 39 146 940           | 57                             |
| 19  | Rzeszów district         | 70 411 000                                      | 25 897 000  | 44 514 000           | 63                             |
| 20  | Jasło district           | 92 749 271                                      | 65 299 000  | 27 450 271           | 30                             |

Source: own study based on data of The Main Office of the Podkarpackie Province in Rzeszów

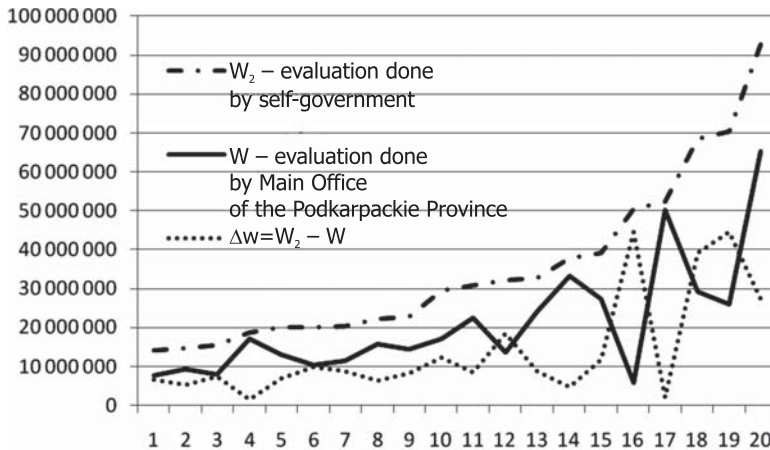


Fig. 2. Balance sheet of valuations and differences of flood results for twenty biggest values of loss (in PLN)

Source: own study based on data of The Main Office of the Podkarpackie Province in Rzeszów

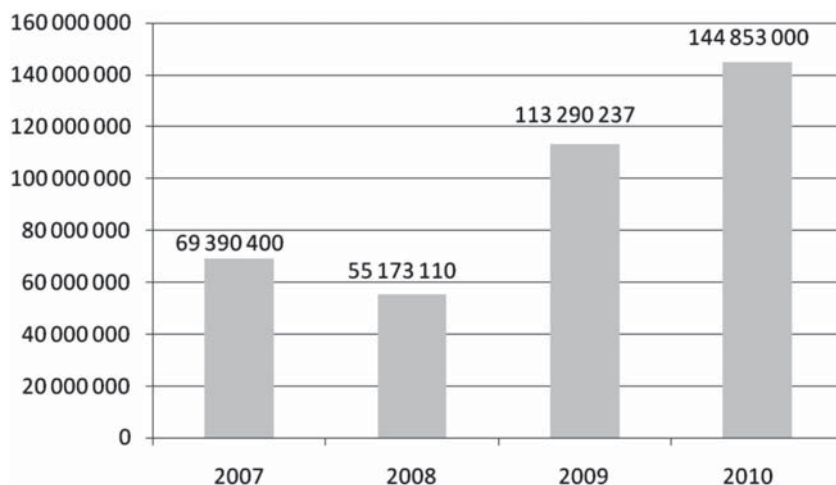
Figure 2 shows results presented in table 3. The discrepancies between valuations are very big which strongly undermines the credibility of prepared estimations. It is also hard to assume that the people preparing them for small flood losses do their work reliably whereas with bigger sums of money they do not respect the standards and prepare very high valuations.

### 3. The Valuation of the Flood Losses Versus Feasible Possibilities of the State

Very big discrepancies of the flood losses between two statements increase proportionally to the value of the flood losses. The sums of losses caused by the flood only in May and June exceeded one billion PLN. These were the most serious losses of property in the recent years but it should be remembered that in 2010 there were four floods, not to mention minor floodings.

Figure 3 shows the values of paid sums as flood losses in the years 2007–2010.

The balance sheet of the payments for the local governments in the years 2007–2010 in comparison with the earlier data estimating flood losses shows a great discrepancy between factual losses and sums paid for the local governments. The differences between sums received from The State Treasury and actual expenses will have to be covered by the local governments from their own budgets. Unfortunately in many cases there is no reconstruction of the state property due to the lack of financial resources.



**Fig. 3.** Balance sheet of the sums paid for the local governments of the Podkarpackie Province in the years 2007–2010 as flood losses (in PLN)

Source: own study based on data of The Main Office of the Podkarpackie Province in Rzeszów

#### 4. Conclusions

- Analysis of differences in perceptions can be used to compare pairs of valuations for sufficiently large data sets.
- Comparison of 142 pairs of valuations made on the basis of Secocenbud pricing proved there is a strong systematic factor for the studied valuations.
- High reliability of estimates was observed for the results of flood losses for the sums of a few hundred thousand and a low reliability for losses over a few million.
- Systematic factor is probably the result of two opposing tendencies, i.e. the natural tendency to overestimate the amount estimated by the government and the lack of financial resources in the state budget to under-estimated loss by the party representing the State Treasury.
- Studies on the effects of flood in 2010 in comparison to the amounts disbursed for the period 2007–2010 show that fixed assets are reconstructed at the level of 10–20% compared to the total losses.
- It would be very valuable to compare the flood losses with the sums needed to build adequate flood protection. Unfortunately, the author has no relevant data. The practice of many countries shows that flood prevention is often several times cheaper than removing flood results. It should be noted that the data collected do not cover losses of personal property of residents of Podkarpackie Province.



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## References

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