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Assessment of drought potential risk for Upper and Middle Odra Watershed

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In the face of disastrous natural events, occurring more and more frequently in the last decades, the scientists of different domains concentrate their efforts on developing the methods of risk estimation of the dangerous phenomena occurrence. The risk problem is formulated and addressed in different ways, in number of studies (Louvar & Louvar 1998, Szopa 2004, Ven Te Chow et all. 1988), depending on subjective domain and specific purposes of investigation. The first step of risk analysis is usually a procedure aimed at assessing potential risk (hazard) of dangerous phenomena occurrence.

The task of hydrologists in this area is to determine the potential risk concerning such extreme events as flood hazard and droughts. Flood hazard analysis for design purposes, flood protection and water management planning commonly involves evaluation of cumulated risk as the final outcome of sequence of elementary events, without investigating the particular role of each of it. If long empirical streamflow series are available, flood hazard is obtained on the basis of statistical analysis of extreme discharge values (Ozga-Zielinska, 2000).

Drought potential risk estimation constitutes more complex problem, because many influencing factors should be taken into consideration, as well as a real extent of drought and duration aspect**.** Moreover, severe droughts affect many fields of human life, environmental condition and numerous economy branches. Thus, in the literature, drought event definitions vary considerably, indicating different aspects of drought depending on the aim of a study and methods of droughts events identification. Recently published book: „ Hydrological drought" (ed. Tallaksen & Van Lanen, 2004), summarized the experiences of hydrologists working in the frame of Low Flow Group of FRIEND project, give the overview and clarify terminology, definitions, drought characteristics and methods of their estimation.

In the presented study the definition of a hydrological drought, criteria of drought events separation, methods of derivation drought indices have been used in accordance with the criterions recommended in this book.

The main purpose of drought events analysis for Odra Watershed was evaluating the degree of drought hazard and spatial distribution the selected classes of risk within the watershed. The analysis comprises atmospheric drought events and hydrological drought, characterised by streamflow and groundwater drought indices.

Daily depth of rainfall, recorded at rain gauge stations within Upper and Middle Odra Watershed in period 1966-2003 were used in the study for assessing atmospheric **drought index.** Rainfall deficit, computed as percentage of normal rainfall for a given period assumed to be the adequate measure of atmospheric drought. The most severe drought occur in Odra Watershed in summer, during growing seasons, when atmospheric drought is intensified by high rates of evaporative loss. The characteristic deficiency period beginning here in June and lasts up to October.

Two streamflow drought indices have been chosen base on low flows occurrence analysis.

Daily discharge data from the period 1966-2003 and for 76 subcatchments within Odra Watershed were used for low flows events selection. Application threshold level method enabled separation streamflow drought periods. Truncation level was established at 90 percentile from flow duration curve, below which the flow (low flow spell) is considered as a drought. Streamflow drought characteristics were computed from daily flow data for all subcatchments using NIZOWKA computer programme (Jakubowski, 2003). The programme allows computation of combined probability of streamflow drought occurrence and probability of exceeding a given value of runoff deficit or stated duration of drought, in days. As the empirical flow series were too short for directly frequency analysis, several plausible probability distribution functions, included to the programme enabled quantiles computation. To eliminate minor drought and dependent events from the streamflow droughts series, minimal drought duration criterion and droughts separation procedure have been applied. The number of droughts occurring in time interval (ex.: one year) treated as a discrete random variable, are described in the programme by binomial Pascal or Poisson distribution.

In the case of the second variable – deficit volume, the best fits to the data series appeared the most frequently distribution: LogNormal and Pareto.

Two low flows characteristics: probability of low flow occurrence in each year and deficit runoff volume (standardized by mean annual runoff volume) with 1% probability of exceedance were accepted as the streamflow droughts indices and included into regional analysis.

Groundwater drought index is represented in the study by minimal groundwater contribution to streamflow, during drought periods. Complex geology structure, especially at Sudety Mountains, makes the difficulties in representatives of measure points estimation and enabled elaboration groundwater characteristics on the basis of groundwater level measurements. Assuming that during severe drought period groundwater yield is the only source of river supply and using recession curve model proposed by Radczuk and Szarska (1989), base flow level (Q_b) for investigated catchments have been computed. The lowest (Q_b) within multi-years period, derived from recessions at each site, was adopted as a groundwater drought measure and introduced to further computation in the form of base flow specific runoff (q_b).

The spatial distribution of catchment areas is represented in digital form in the topologic vector model as the polygons. Each polygon is encoded in the database as a logical record and it's defined by a string of X – Y coordinates representing a closed area. In this model is possible transformation of geometric configurations and the mathematical study of the relationships. The attribute values are stored in relational tables. Each column represents different fields of selected attributes (rainfall deficit, streamflow drought index, groundwater drought index). Spatial analysis of subdivided attributes was carried out by using reclassification and overlay operations. The first process involves pooling procedure of the attribute for a single data layer and enables assignation a resultant attribute - the new class. Overlaying of maps creates new spatial entities. Here the values are computed as a function of the independent values associated with the same location (catchment) in two or more existing maps, created in reclassification procedure. New spatial entities – drought risk high, medium, and low, is formed by logical overlaying with the operators AND (intersection) or OR (union). The procedures were carried out by using ArcGis programme.

As a result, we obtained areas representing tree classes of drought risk. The low potential risk of drought occurs in part of Karkonosze Mountain with the upper Bobr and Kaczawa catchments. Those areas are characterized by high and frequent precipitation. The high potential risk appears in the middle course of Odra River, in Nysa Luzycka basin in upper part of Nysa Klodzka basin and in the few catchments of upper Odra watershed, all located in upland and lowland areas. The medium of drought potential risk include Sudeten Foothills and part of the upper Odra River without Orla basin, which is a typical lowland catchment.

The problem of drought potential risk should be considered not only in the basin system but also with the reference to public demands for fresh water and agricultural needs. The presentation of spatial distribution of drought potential risk against a boundary district background constitutes a useful tool for planning of water management in the basins and within the administrative unites.

CONCLUSSIONS

Droughts, in climatic condition of the Middle Europe have a character of natural hazards. The study aimed at distinguishing the area with high potential risk of drought, in Odra Watershed will be the basis for improving decision support system in regional water management .

The map showing droughts potential risk in the Watershed may serve Regional Water Authorities improving policy of water resources management and District Authorities reliable for execution of space economy planning.

The spatial distribution of drought potential risk against a boundary district background should be use, as an important tool supporting program of future droughts mitigation undertaken within Small Retention Development Programme.

REFERENCES

Jakubowski W., 2003, Guide and computer program NIZOWKA. Mathematic Division, Agricultural University, Wroclaw.

Dubicki A., Tokarczyk T., et al., 2002: Water resources In the upper and middle Odra river basin under drought conditions, IMGW Warszawa.

Louvar J.F,LOuvar B.D.,1998, Health and environmental risk analysis; Fundamentals and applications. New Jersey, Prentice Hall.

Ozga-Zielińska M., 2000, Hydrological risk assessment for water structure design, pp 70-88

In: Risk in water management, ed. Maciejewski M., Monografie Kom. Gosp. Wodn. PAN nr 17.

Radczuk L., Szarska O. (1989) Use of the flow recession curve for the estimation of conditions of river supply by underground water, In: FRIENDS in Hydrology, Publ. IASH no. 187, pp 79-88.

Szopa T., 2004, Maps of risk areal distribution, Warsaw Technical University, EDURA publ.

Tallaksen L. M., Van Lanen H. A. J., 2004, Hydrological Drought, Processes and estimation methods for streamflow and groundwater, ELSEVIER.