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Limit of detection values in data analysis: do they matter?

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Data sets containing values below the limit of detection (LOD) are known as 'censored data sets'. Such data sets are encountered regularly in most fields of environmental contaminant research. When analysing these data, it is necessary to decide how values below the LOD should be treated. A range of approaches have been proposed, and adopted to varying degrees, within the peer-reviewed literature. These include: (i) treating the LOD value as the absolute value (i.e. if the LOD value is <0.5 then the value of 0.5 will be used); (ii) treating the LOD values as zero; (iii) excluding the LOD values from the data set; and (iv) substituting the LOD value with a value between zero and the LOD value, most commonly a value equivalent to half of the LOD value. Whichever method is employed, the values used to produce a non-censored data set have limitations and deficiencies when it comes to subsequent data analysis and interpretation. At best, these approaches serve as a simplistic means for approximating reality but, at worst, they may result in unjustified conclusions being drawn.

Alternative methods that could be used to overcome this problem have been proposed. These methods, known as survival analysis methods, were originally developed for analysing medical data. They offer a means of analysing censored data sets without the need for modifying the LOD values. Two recent papers have recommended the use of survival analysis methods in the field of environmental radioactivity research (Fievet & Della Vedova, 2010; Wood *et al.*, 2010), but there is a need to build a case for their adoption within this field and to provide guidance on their use.

In this paper we consider the pros and cons of current norms for handling censored data and highlight the influence of LOD treatment choice on the results obtained. We then introduce the range of survival analysis methods and question whether these methods should be adopted more widely within our research community. We establish the evidence base for the adoption of survival analysis techniques in other areas of environmental science and compare the results of these methods with the data fabrication approaches that are commonly used. We then provide guidance to facilitate environmental radioactivity researchers in selecting justifiable techniques for analysis of censored data sets in the future.

References

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Wood MD, Beresford NA, Semenov DV, Yankovich TL, Copplestone D, 2010. Radionuclide transfer to reptiles. Radiation and Environmental Biophysics. DOI: 10.1007/s00411-010-0321-1