Monitoring of treated domestic waste water quality

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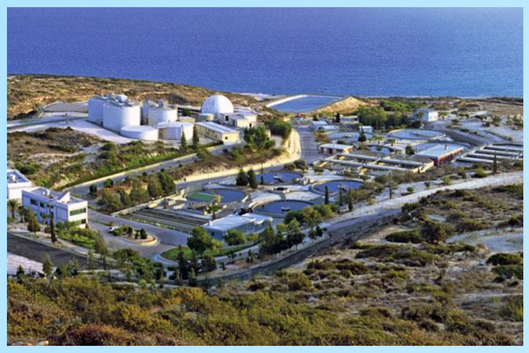
1. INTRODUCTION

Cyprus is an island experiencing severe water supply and demand imbalances particularly in summer months. This is due to the simultaneous occurrence of low precipitation, high evaporation and increased demands for irrigation and tourisms. Several strategies have been developed in Europe in general in order to face water shortages and at least two major environmental directives 91/271/EEC (UWWTD) and the Framework Directive 2000/60/EC (WFD) directly or indirectly raise the issue of waste water reuse.

In Cyprus there are 36 treatment plants

- Large plants for Urban Wastewater (7)
- Rural waste treatment plants (29)
  - communities >2000P.E,
  - communities <2000P.E
  - military camps
  - hospitals.



Treated wastes are used for environmental purposes which include recharging aquifers, agricultural irrigation, municipal/landscape uses, that is, irrigation of parks and other green spaces, road washing etc. The quality of treated wastes is monitored by the determination of various parameters including Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD_5), anions, suspended solids, total nitrogen, total phosphorus, metals, pesticides and Polycyclic Aromatic Hydrocarbons (PAHs), in order to ensure compliance with the quality requirements of the operating permits of the treatment plants.

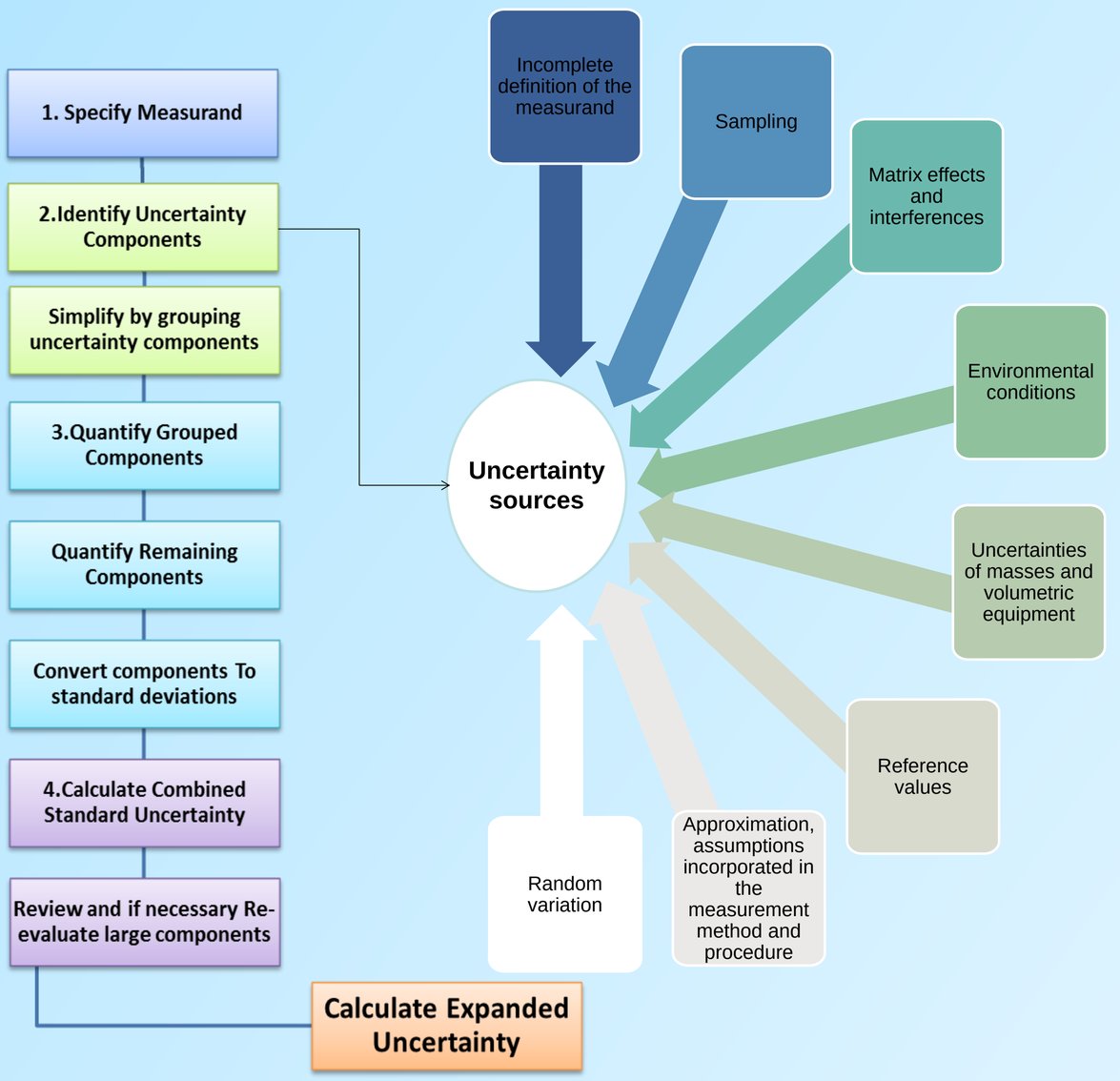
Validated/accredited methods for the determination of these parameters are used. Validation includes mainly precision, recovery, limit of quantification and uncertainty.

2. Uncertainty

Uncertainty of measurement is: “A parameter associated with the result of a measurement, that characterises the dispersion of the values that could reasonably be attributed to the measurand “.

The uncertainty on the result may arise from many possible sources.

3. Estimation Process



4. Calculation of the Relative Combined Uncertainty

$$\frac{U_c}{c} = \sqrt{(RSD_{RL})^2 + \left(\frac{U_\kappa}{C}\right)^2 + \left(\frac{U_{bias}}{C}\right)^2 + \left(\frac{U_V}{V_V}\right)^2 + \left(\frac{U_R}{R}\right)^2 + \left(\frac{U_m}{m}\right)^2 + \ldots}$$

I) RSD_{RL} : Relative standard deviation under reproducibility conditions

II) U_κ /C : Relative Uncertainty due to the calibration curve

III) U_{bias}/C : Relative uncertainty from Certified Reference Materials (CRMs)

IV) U_V/V_V : Relative Uncertainty due to volume

V) U_R/R : Relative Uncertainty due to the recovery of the measurand

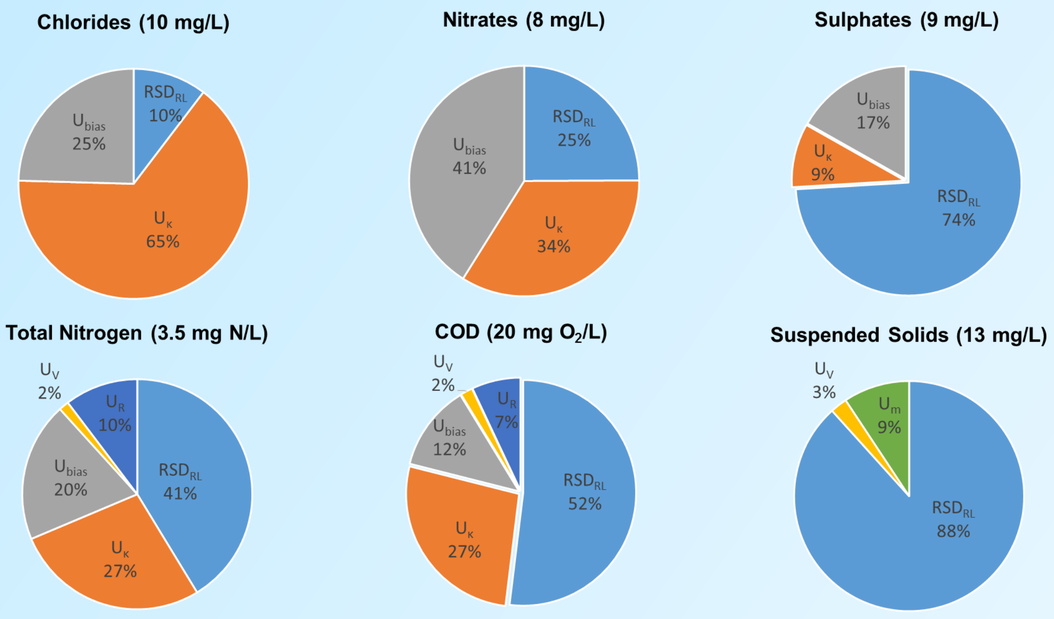
VI) U_m/m : Relative Uncertainty due to mass

5. Calculation of the Expanded Uncertainty

The expanded uncertainty is obtained by multiplying the standard combined uncertainty by a coverage factor of 1,96.

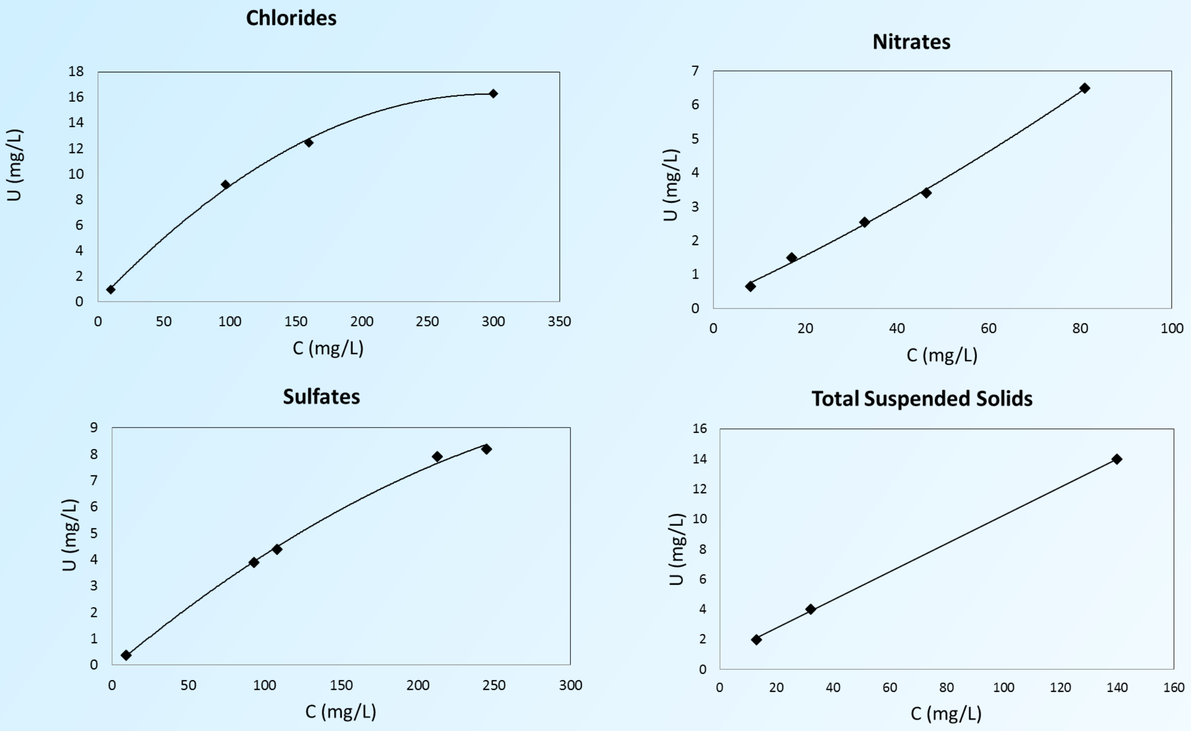
$$U_{exp} = U_c \times 1{,}96$$

6. Source contribution to uncertainty

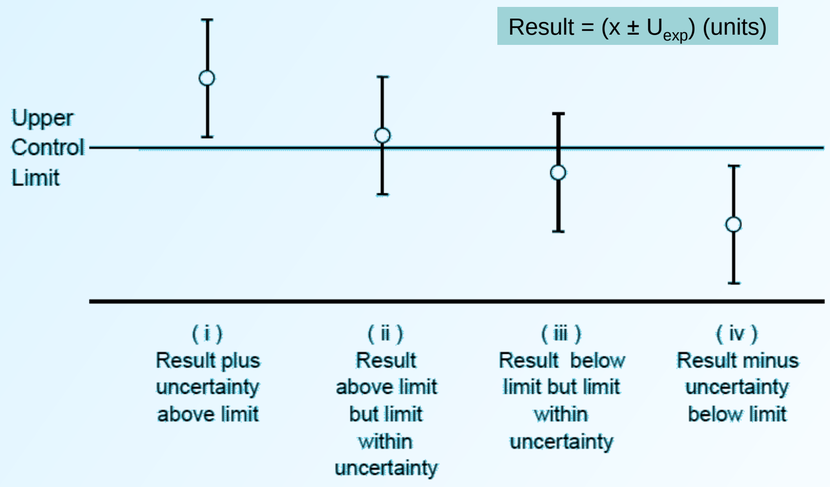


7. Uncertainty vs concentration relationships

A relationship between uncertainty and concentration has been derived and is shown below for some of the parameters.



8. Reporting expanded Uncertainty



9. Conclusion

Uncertainty is used for assessing compliance with the limits set in the discharge permit of the waste water treatment plants.

10. Bibliography

a) EURACHEM/CITAC Guide CG4, Quantifying Uncertainty in Analytical Measurement, Third Edition (2012).
b) NORDTEST Technical Report 537, Edition 3.1: Handbook for calculation of measurement uncertainty in environmental laboratories. NORDTEST 2012
c) Standard Methods for the examination of water and waste water 21nd edition, APHA,AWWA,WEF
d) EN ISO/ IEC 17025:2005