

# 5<sup>TH</sup> SBSE INTERNATIONAL MEETING

23 & 24 SEPTEMBRE 2019 - NOVOTEL PARIS-SUD

**SBSE**   
Technical Meeting



# Implementing Green into analytical daily work

Bastien Raccary – The Green Analytical Project



# Impacts of global heating on the practice of analytical chemistry



Paris, 2050

Heat peaks are more common and more frequent.

Heat days increase from **7 days per year** to **41 days per year**.

The 2003 heat wave has become the norm.

Heating needs: -22%.  
Air conditioning needs: **+135%<sup>1</sup>** !

No big deal !



**BUT**

**BUT**

Each summer, power consumption restrictions could be applied by governments.

So ?

Decrease in wind turbine production due to anticyclonic conditions (-33% in 2018)<sup>2</sup>

Reduction in nuclear production due to lower cooling capacity (-10% in 2018)<sup>3</sup>

**Be proactive and don't get trapped !  
Consum less and wisely !**

Sources : <sup>1</sup>Carbone 4, « Impacts of climate change, what can be expected in France ? »

<sup>2,3</sup>[https://www.rte-france.com/sites/default/files/synthese\\_passage\\_ete\\_2018.pdf](https://www.rte-france.com/sites/default/files/synthese_passage_ete_2018.pdf)



# Impacts of global heating on the practice of analytical chemistry



Paris, 2050

Heat peaks are more common and more frequent.

Heat days increase from **7 days per year** to **41 days per year**.

The 2003 heat wave has become the norm.

In France, productivity fell by 3% in factories during the 2003 heat wave<sup>1</sup>.

Production decline of 6%, resulting in a 2.5% decrease in the turnover of the chemicals sector in Germany due to the drought<sup>2</sup>.



**Decreasing operator well-being and productivity.**

**Possible supply disruptions in solvents and various other supplies...**



**Our activity depends on a multitude of industrial and institutional players.**

**If one link in the chain is not resilient, the entire chain can be impacted.**



Sources : <sup>1</sup> <https://www.senat.fr/rap/r03-195/r03-1951.pdf>

<sup>2</sup> <https://www.lesechos.fr/industrie-services/industrie-lourde/la-chimie-allemande-sattend-a-une-annee-2019-difficile-999834>



# The Green Analytical Project : Who we are !

A **think tank** studying green analytical chemistry

Created in the end of 2018 by Christophe Pérès →  
*R.I.C and head of analytical research at **Chanel***



## Our aim ?

**MAKE ANALYTICAL CHEMISTRY GREEN AGAIN!**

Welcome to the  
**GREEN SIDE**  
We have cookies



[www.thegreenanalyticalproject.org](http://www.thegreenanalyticalproject.org)

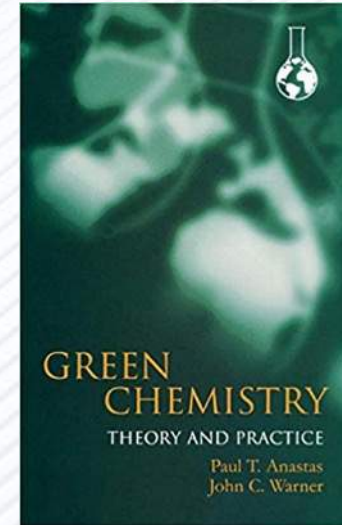


# Green Chemistry and Green Analytical Chemistry



Paul Anastas

John C. Warner



**1998**

Green Chemistry :  
Theory and Practice

The use of chemistry skills and knowledge to **reduce or eliminate the use or production of hazardous substances** in the research and development, manufacture and use of chemicals in order to **minimize threats to the health of operators and to the environment.**



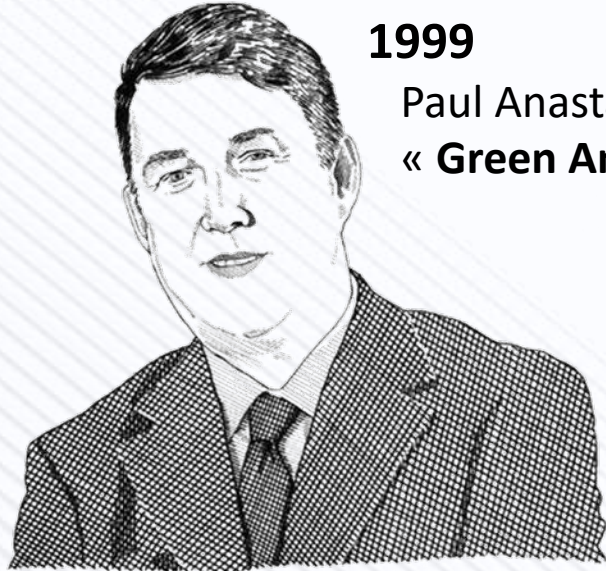
**12 principles of Green Chemistry**



# Green Chemistry and Green Analytical Chemistry

**1999**

Paul Anastas is also the first to use the term of  
« **Green Analytical Chemistry** »



Back in **1993**, Miguel de La Guardia already published  
« **Towards environmentally conscientious Analytical Chemistry  
through miniaturization containment and reagent replacement** »



Humans are a part of an ecosystem and science has an  
environmental impact



# Green Chemistry and Green Analytical Chemistry

## 12 principles of Green Chemistry

- P** – Prevent waste
- R** – Renewable materials
- O** - Omit derivatization steps
- D** – Degradable chemical products
- U** – Use safe synthetic methods
- C**– Catalytic reagents
- T**- Temperature, Pressure ambient
- I** – In-Process Monitoring
- V** – Very few auxiliary substances
- E** – E-factor, maximize feed in product
- L** – Low toxicity of chemical products
- Y** – Yes it's safe

Anastas et al., 1998

## 12 principles of Green Analytical Chemistry

- S** - Select direct analytical techniques
- I** - Integrate analytical processes and operations
- G** - Generate as little waste as possible and treat it properly
- N** - Never waste energy
- I** - Implement automation and miniaturization of methods
- F** - Favor reagents obtained from renewable source
- I** - Increase safety for operators
- C** - Carry out in situ measurements
- A** - Avoid derivatization
- N** - Note that the sample number and size should be minimal
- C** – Choose mutli-analyte or multiparameter method
- E** - Eliminate or replace toxic reagents

Galuzska et al., 2013

## So... Now what ?!





# Overview of the situation

The ecological dimension is almost never included in the development stage of an analytical method.



**Environmental  
impact ?**

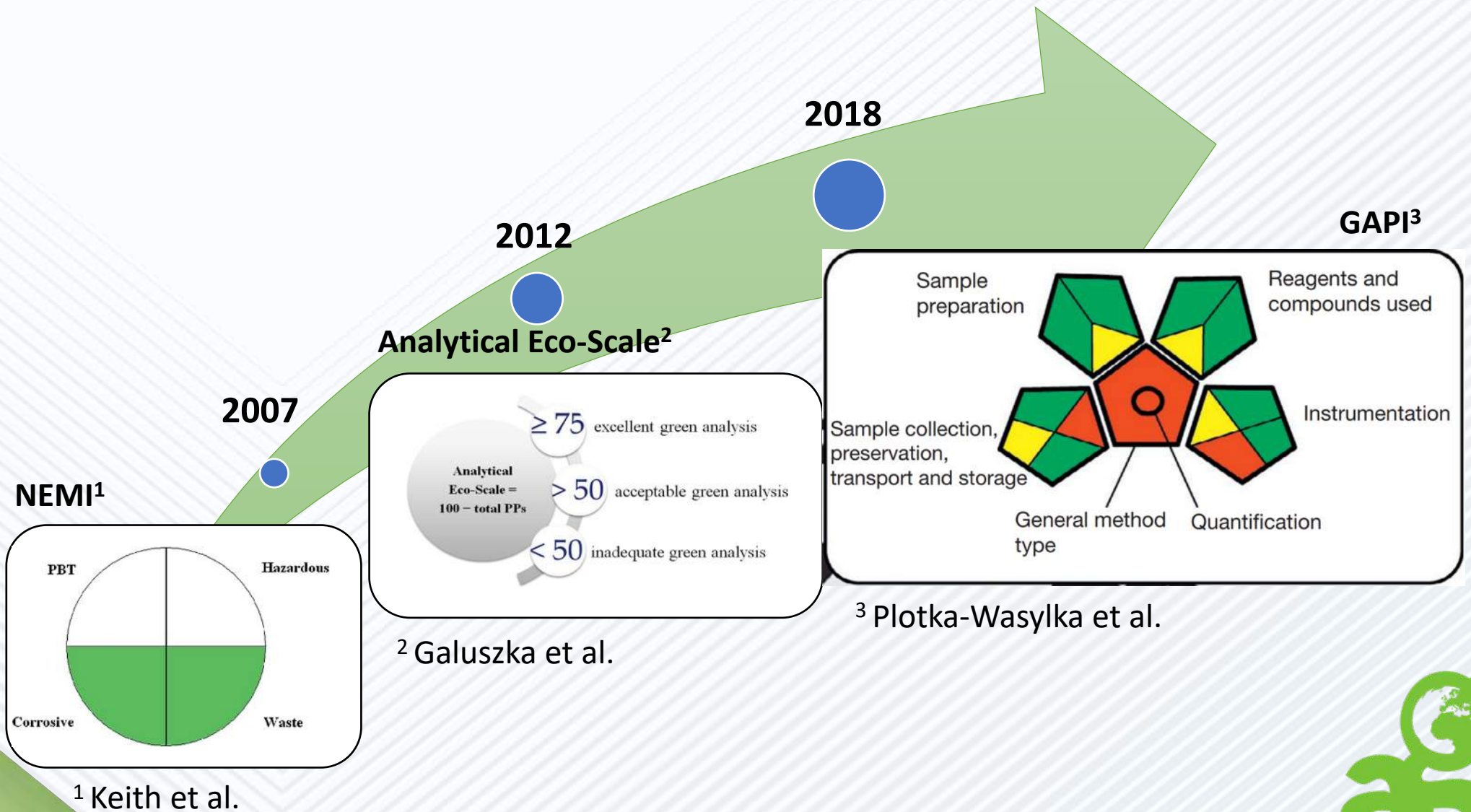
**These instruments are our best friends, but what about their power consumption?**

**Are they really that friendly towards our eco-system?**

**Are our laboratory practices environment-friendly ?**



# Tools to assess the greenness of an analytical method

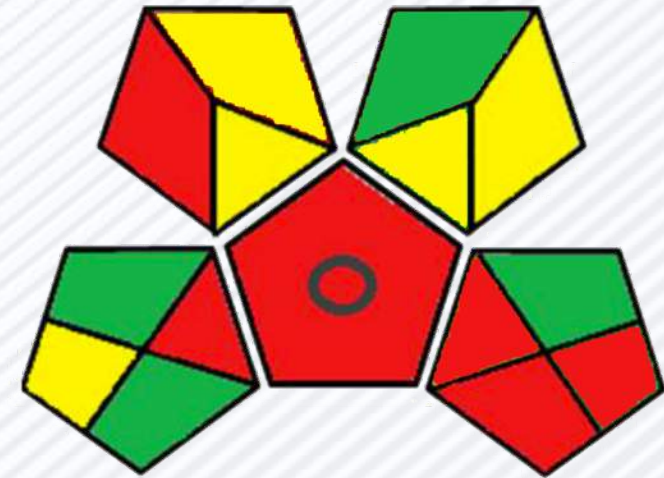
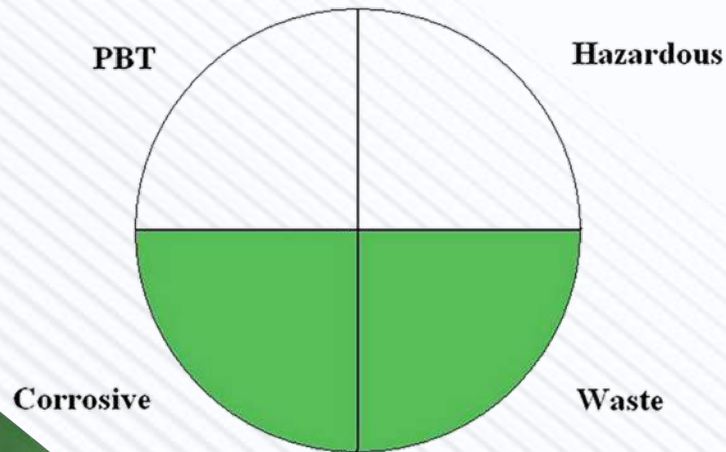


# Application of the tools to application notes

Application note :

## SPE Extraction of Pesticides from Water using SiliaPrep Reversed-Phase C18

Approximately 10mL of dichloromethane and 25mL of methanol



# What about SBSE ?



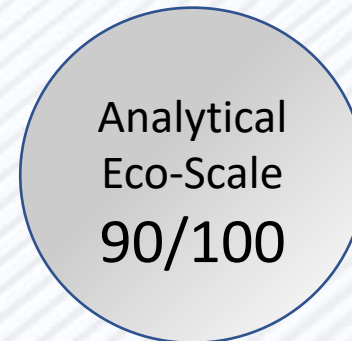
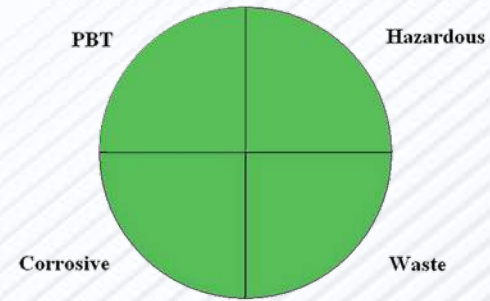
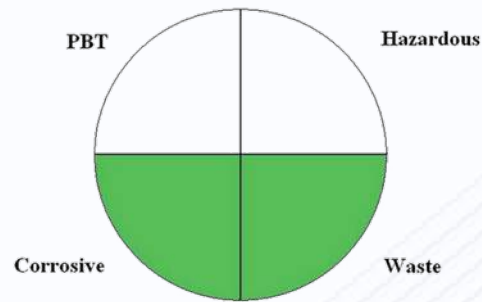
Application note 2003/1 :

Stir Bar Sorptive Extraction (Twister™) RTL-CGC-MS.

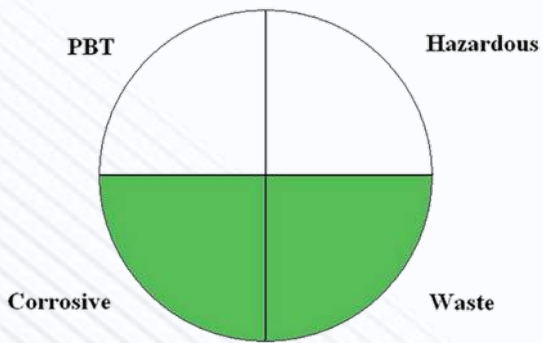
**A Versatile Method to Monitor more than 400 Pesticides in Different Matrices  
(Water, Beverages, Fruits, Vegetables, Baby Food)**



# SPE application note<sup>1</sup> SBSE application note<sup>2</sup>



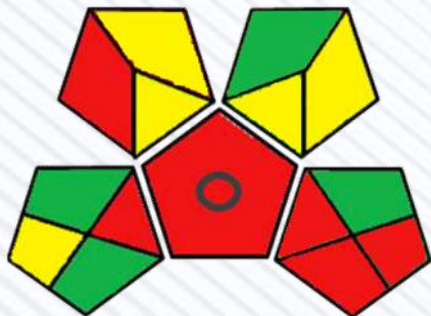
Sources : <sup>1</sup> SPE Extraction of Pesticides from Water using SiliaPrep Reversed-Phase C18  
<sup>2</sup> A Versatile Method to Monitor more than 400 Pesticides in Different Matrices (Water, Beverages, Fruits, Vegetables, Baby Food)



- Does not include **energy**
- Does not measure the **impact of different solvents**
- Assumes that the use of 100mL or 3.5L of solvent has an **equivalent impact**

**Number of signal words has a strong impact on the note**  
➔ Not much their content

Analytical  
Eco-Scale



- **Not easy to interpret**
- **Semi-quantitative**

Some thoughts...



# What about...

**Multi-analyte analysis/extraction ?**

*“Choose mutli-analyte or multiparameter method”*



**Mobile phases ? Carrier gas ?**



**Solutions ?**

*“I want to improve my analytical method, what do I do now ?”*



**Energy mixes of countries ?**



# Life Cycle Assessment



## POWERFUL AND HOLISTIC TOOL

**Life cycle assessment (LCA)** is already used for Green Chemistry

Quantitative

Multicriteria

From cradle to grave





# What's next



## RESEARCH

Doctoral thesis

« The ecological transition in analytical chemistry: towards a multi-criteria evaluation based on life cycle analysis. »

université  
de BORDEAUX



## 2020 : A LABEL FOR LABORATORIES

A label to reward laboratories that have engaged in a successful green strategy.



## BUT ALSO...



## INFORMATION AND SCIENTIFIC MONITORING

Annual reports, editorials...

## PEDAGOGY

Webinars, conferences...



STAY TUNED !

Thank you for your attention !

Questions ?

