Decision Support Systems for nitrogen pollution reduction in agriculture systems. A case of Valencian Community (Spain)

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1.- INTRODUCTION

PLANET SUSTAINABILITY

Planetary boundaries for the safe/sustainable operating of the planet.

- Biodiversity loss
- Atmospheric aerosol loading
- Chemical pollution
- Climate change – Carbon cycle
- Ocean acidification
- Stratospheric Ozone Depletion
- Nitrogen cycle
- Phosphorus cycle
- Global freshwater use
- Change in land use


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1.- INTRODUCTION

NITRATE POLLUTION

NO₃ groundwater (mg/L) -

Source: Database Conselleria Agricultura Comunidad Valenciana (2009).

Nitrate Vulnerable zones
000
004
009
018 (propuestos)
018 eliminados
o vulnerables

Nitrate Vulnerable zones. DOGV 5/7/2018

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1.- INTRODUCTION

VALENCIAN AGRICULTURAL SYSTEM

1.- Irrig. system
Flood (30%)
Drip (70%)

2.- Water quality
Groundwater
Surface
Alternative

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VALENCIAN AGRICULTURAL SYSTEM

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Alternative

<table>
<thead>
<tr>
<th>Crop</th>
<th>Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Citrus</td>
<td>161 000</td>
</tr>
<tr>
<td>Vegetable</td>
<td>25 000</td>
</tr>
<tr>
<td>Fruit tree</td>
<td>43 000</td>
</tr>
<tr>
<td>Vine</td>
<td>22 000</td>
</tr>
<tr>
<td>Olive</td>
<td>11 000</td>
</tr>
</tbody>
</table>

SUSTAINABILITY PROBLEMS
- Nitrate pollution
- Low NUE

FERTINNOWA

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### NITROGEN USE EFFICIENCY-NUE

<table>
<thead>
<tr>
<th>ESTIMATION</th>
<th>N lost (kg N/ha)</th>
<th>NUE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAGRAMA (2015)</td>
<td>211</td>
<td>46*</td>
</tr>
<tr>
<td>de Paz et al. (2009)</td>
<td>183</td>
<td>45**</td>
</tr>
</tbody>
</table>

\*\*NUE = \( \frac{N_{output}}{N_{input}} \) * 100

\**NUE = \( \frac{N_{crop}}{(N_{min} + N_{irri} + N_{ferti})} \) * 100

### NITROGEN MANAGEMENT

- **Fixed rates**
- **Organic fertilization is not considered**

### SITE-SPECIFIC N MANAGEMENT-SSNM

- (MacCarthy et al. 2018)

### RECOMMENDATION SYSTEMS

- Based on DSS-models

### INTEGRATED SOIL FERTILITY MANAGEMENT

- Integrate organic matter in fertilization recommendation

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DSS-BASED ON SIMULATION MODELS

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- $N_{extr} = \text{Prod} \times K_{upt} \times F_{n_u}$
- $ETc = Kc \times ETo$
- $\%N = C_1 \times TDM - C_2$
- $NO3_{lix} = N_{min} \times (1 - e^{-k\times dren/Por})$
- $N_{min} = No \times (1 - e^{kt})$
DEFINITION OF DECISION SUPPORT SYSTEM

**DSS**: A interacting computer-based system that helps the decision maker in the use of data and models in the solution of unstructured problems. (Scott-Norton)

DSS groups scientific and expert knowledge in a structured way to make it available to users by an interface.
2.- DSS-MODEL

PROBLEMS TO BE CONSIDERED IN THE DEVELOPMENT OF A DSS-MODEL

– Model complexity
  • Models are not adapted to Valencian agricultural systems. (farmer skills, data availability, etc.)

– High uncertainty
  • Model
  • Input data

– Unfriendly interface
  • Non implemented in WEB or App.

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2.- DSS-MODEL

CHALLENGES TO EXTEND THE USE OF DSS IN VALENCIAN COMMUNITY

- To develop a simple model adapted to valencian agricultural system
  - Crops (vegetables, citrus, persimmon, vines etc.)
  - Low technologic profile
  - Low data requirement

- Friendly graphical user interface-GUI
  - Simple and intuitive GUI. Farmers should participate in the design.
  - Supported databases
    - Climate
    - Soil
    - Water
    - Crop

- Implemented in WEB or/and App

DSS-SALTIRSOIL
agrosal.ivia.es

1’s Horizon 2020 research and innovation programme under grant agreement No 689687
2.- DSS-MODEL

NITIRSOIL MODEL

- Simulate main N balance terms
- Low data requirements
- Simple GUI.
- Supported by databases (soil, water, climate, crop, fertilizers, wastes etc.)
- Calibrated-validated for main valencian crops
- Developed in visual studio .net 2012 and adapted to be implemented in a WEB site.

Calibration: N uptake
  ○ Lettuce, potato, artichoke, onion, cauliflower, citrus.

Validation: N leaching, Δ Nmin soil.

De Paz et al 2012. 17th N workshop Innovations for Sustainable Use of Nitrogen Resources.
### 3. DSS-DATABASES

<table>
<thead>
<tr>
<th>Soil database</th>
<th>Water database</th>
<th>Climate database</th>
</tr>
</thead>
<tbody>
<tr>
<td>- 480 points</td>
<td>Control points:</td>
<td>- 54 weather stations</td>
</tr>
<tr>
<td></td>
<td>- 1040 groundwater</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 145 surface</td>
<td></td>
</tr>
</tbody>
</table>

**Crop database:**
- 55 annual crops
- 22 fruit trees

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5.- DSS-WEB (or App) STRUCTURE

DATA INPUT
(PHP, javascript, html)

ANALYSIS AND DATA INTERPRETATION
(Visual studio 2012 . Net)

RECOMENDATION
(PHP, javascript, html)

MANAGEMENT

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<th>Crop</th>
<th>Climate</th>
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Graphical user interface-DSS

NITIRSOIL model

Interpretation of model results and decision algorithms

- Reports
- Warnings
THANKS FOR YOUR ATTENTION

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