Application of a SWAT model to assess the impacts of diffuse pollution from vineyards in north-central Portugal

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1. INTRODUCTION

ITACUA Project

Hydrological processes
Aquatic pollution (nutrients and pesticides)
Chemical and ecological status

System simulation

Model simulations (SWAT model)

Climate Change Impact Assessment

Impacts of climate scenarios (for 2050 and 2100) on hydrology, agrochemical exports and surface water quality status
Test adaptations in agricultural practices to climate change

Monitoring data will be used for model calibration and validation

Field monitoring

Suspended solids
Total N and P
Pesticides

Biological

Fish
Periphyton
Macrophytes
Macroinvertebrates

Hydro-morphological

River habitat survey

Multidisciplinary approach

Laboratory simulations of aquatic systems

Model outputs based on future climate scenarios will be used in the laboratory bioassays

Combined effects of temperature and pesticides on the aquatic ecosystem functioning under present and future climate scenarios.

Microcosm simulations
1. INTRODUCTION

Why focusing on vineyards?

i) The importance of the wine sector for the national context (vineyards represent more than 250,000 ha)

ii) Viticulture is highly dependent on the use of pesticides and fertilizers (mainly applied from February to September)
2. OBJECTIVES

- Evaluate the **reliability of the model to simulate the input of agrochemicals (nutrients and pesticides) to aquatic systems in intensive vineyard areas and to reproduce the water chemical status.**

  - **Sub-basin scale**

- Evaluate the **impacts of climate changes** on vineyard productivity, hydrology, agrochemical exports and surface water quality status.

  - **Catchment scale**
3. METHODOLOGY

Study area

São Lourenço sub-basin
- Area: 620 ha
- Vineyard area: 198 ha

Cértima basin
- Wine origin denomination: *Bairrada*
- Total area: **53 800 ha**
- Vineyard area: **12 000 ha**
3. METHODOLOGY

Data collection – experimental design

Totalizer rainfall gauge

Automatic rainfall gauge

Stream

Water Sampler

Limnigraph
3. METHODOLOGY

Data collection (weekly or bi-weekly)

Runoff

Superficial waters

Groundwaters

Soil moisture

Hydrometric station

Automatic sampler
3. METHODOLOGY

Water quality parameters

- **Basic physicochemical parameters** – Temperature, pH, Conductivity, Dissolved oxygen, Total Suspended Solids;

- **Nutrients** – Nitrates, Total Nitrogen and Total Phosphorus

- **Pesticides** (16)
  - **Herbicides**
    - Terbuthylazine
  - **Insecticides**
    - Chlorpyrifos
    - Flufenoxuron
  - **Fungicides**
    - Azoxystrobin
    - Cymoxanil
    - Dimethomorph
    - Folpet
    - Metalaxyl
    - Myclobutanil
    - Penconazole
    - Pyraclostrobin
    - Pyrimethanil
    - Quinoxyfen
    - Tebuconazole
    - Trifloxystrobin
    - Copper sulphate
4. MODELING

Model set-up

Digital Elevation Model (DEM)  Watershed delineation

Stream definition:  Area = 10 ha
Nr. cells: 1000

10 sub-basins
4. MODELING (Set-up)
5. RESULTS AND DISCUSSION

Water flow rates

Arnold’s et al. (1995) recursive filter

Baseflow recession constant (Alpha Bf) = 0.172
5. RESULTS AND DISCUSSION

**Runoff**

*No significant differences (ANOVA, p>0.1) in runoff between ploughed and unploughed plots*

*No significant differences (ANOVA, p>0.1) in Total Suspended Solids (TSS) between ploughed and unploughed plots*
5. RESULTS AND DISCUSSION

Soil moisture

Top of the slope

Bottom of the slope

Moisture is higher on the upper soil layers

Moisture is higher on the deeper soil layers
5. RESULTS AND DISCUSSION

**Pesticides**

- **Tebuconazole** concentrations frequently > L.O.Q. in aquatic systems and vineyard’s runoff
  
  WATER SOLUBILITY = 32 mg L\(^{-1}\); DT\(_{50}\) hydro = 28 days; DT\(_{50}\) soil = 597 days; \(K_{OC}\) = 1.0

- **Metalaxyl** concentrations occasionally > L.O.Q in vineyard’s runoff
  
  WATER SOLUBILITY = 8.41 mg L\(^{-1}\); DT\(_{50}\) hydro = 1 day; DT\(_{50}\) soil = 62 days; \(K_{OC}\) = 163
5. RESULTS AND DISCUSSION

**Microcosm experiments**

- Increase in temperature ➔ higher metabolic/growth rates of primary producers (*Microalgae and macrophyte*) and higher ingestion rates of detritivores (Trichoptera)

- Increase in temperature ➔ higher pesticide toxicity

**EXPERIMENTAL DESIGN:**
- $T = 15$ and $25^\circ C$
- Pesticides: Tebuconazole and CuSO$_4$

Combined effects of **CLIMATE CHANGE AND DIFFUSE POLLUTION** ➔ Negative impacts on aquatic ecosystems.
6. CONCLUSIONS

✓ First steps of SWAT are done
  (Watershed delineation and HRU definition)

✓ Compilation of meteorological data and of vine ecophysiology information (in progress)

7. FUTURE WORK

➤ Model Calibration

➤ Model Up-scaling
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