Group of Environmental Engineering and Microbiology - GEMMA
Department of Hydraulic, Maritime & Environmental Engineering
Universitat Politècnica de Catalunya. BarcelonaTech

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Department of Hydraulic, Maritime & Environmental Engineering

Universitat Politècnica de Catalunya - BarcelonaTech

- Public university (approx. 30,000 students and 4,300 staff)
- 10 different campus located in/around Barcelona
- 23 schools and faculties and 42 departments
- University specialised in architecture, science and engineering: Civil, Mechanical, Electrical, Agricultural, Computer, Telecomunications, Mining, Mathematics, Statistics, etc.
Personnel

PROFESSORS:
- Joan García, Dr. Biology, Full professor
- Ivet Ferrer, Dr. Agricultural Engineering, Assistant professor
- Jaume Puigagut, Dr. Biology, Assistant professor

RESEARCHERS
- Marianna Garfí, Dr. Environmental Engineering, Postdoc Researcher
- Erasmo Cadena, Dr. Environmental Engineering, Postdoc Researcher

PhD STUDENTS:
- Cristina Ávila, Environmental Ciences, PhD Student
- Roger Samsó, Geology Engineer, PhD Student
- Fabiana Passos, Environmental Engineer, PhD Student

RESEARCH ASSISTANTS:
- Eduardo Álvarez, Mechanical Engineer, Technician
- Javier Carretero, Chemical Engineer, Laboratory Technician
Personnel
Research topics

- Natural wastewater treatment systems
  - Constructed wetlands
  - High rate algal ponds
Research topics

- Sludge treatment systems
  - Constructed wetlands
  - Anaerobic digestion

Biogas production

Sludge treatment
Research topics

- Low cost digesters for rural households

Biogas production in rural Andes, Peru
Research topics

- Measurement of greenhouse gases (GHG)
Research topics

- **Mathematical Modelling of biotechnologies**

<table>
<thead>
<tr>
<th>Process</th>
<th>Process rate $r_j$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Hydrolysis</td>
<td>$k_h \times \left( \frac{X_{NH} \times X_{NH} \times X_{NH}}{K_{NH} + X_{NH} + X_{NH}} \right) \times (X_{H} + X_{FB})$</td>
</tr>
<tr>
<td>2 Aerobic growth of $X_f$ on $S_f$</td>
<td>$\mu_f \times \left( \frac{S_f}{K_{GS} + S_f} \right) \times \left( \frac{X_f}{S_f + S_f} \right) \times \left( \frac{S_f}{K_{GS} + S_f} \right) \times \left( \frac{S_f}{K_{GS} + S_f} \right) \times (X_{H})$</td>
</tr>
<tr>
<td>3 Anoxic growth of $X_f$ on $S_f$</td>
<td>$n_f \times \mu_f \times \left( \frac{S_f}{K_{GS} + S_f} \right) \times \left( \frac{X_f}{S_f + S_f} \right) \times \left( \frac{S_f}{K_{GS} + S_f} \right) \times \left( \frac{S_f}{K_{GS} + S_f} \right) \times (X_{H})$</td>
</tr>
<tr>
<td>4 Aerobic growth of $S_a$ on $S_f$</td>
<td>$\mu_h \times \left( \frac{S_a}{K_{GS} + S_a} \right) \times \left( \frac{S_a}{K_{GS} + S_a} \right) \times \left( \frac{S_a}{K_{GS} + S_a} \right) \times \left( \frac{S_a}{K_{GS} + S_a} \right) \times (X_{H})$</td>
</tr>
<tr>
<td>5 Anoxic growth of $X_a$ on $S_f$</td>
<td>$n_a \times \mu_h \times \left( \frac{S_a}{K_{GS} + S_a} \right) \times \left( \frac{S_a}{K_{GS} + S_a} \right) \times \left( \frac{S_a}{K_{GS} + S_a} \right) \times \left( \frac{S_a}{K_{GS} + S_a} \right) \times (X_{H})$</td>
</tr>
<tr>
<td>6 Lysis of $X_f$</td>
<td>$b_{XH} \times X_{H}$</td>
</tr>
<tr>
<td>7 Aerobic growth of $X_a$ on $S_{NH}$</td>
<td>$\mu_a \times \left( \frac{S_{NH}}{K_{GS} + S_{NH}} \right) \times \left( \frac{X_a}{S_{NH} + S_{NH}} \right) \times \left( \frac{S_{NH}}{K_{GS} + S_{NH}} \right) \times \left( \frac{S_{NH}}{K_{GS} + S_{NH}} \right) \times X_a$</td>
</tr>
<tr>
<td>8 Lysis of $X_a$</td>
<td>$b_{XH} \times X_{H}$</td>
</tr>
<tr>
<td>9 Growth of $X_{FB}$</td>
<td>$\mu_{fb} \times \left( \frac{S_{FB}}{K_{GS} + S_{FB}} \right) \times \left( \frac{X_{FB}}{S_{FB} + S_{FB}} \right) \times \left( \frac{S_{FB}}{K_{GS} + S_{FB}} \right) \times \left( \frac{S_{FB}}{K_{GS} + S_{FB}} \right) \times X_{FB}$</td>
</tr>
<tr>
<td>10 Lysis of $X_{FB}$</td>
<td>$b_{XH} \times X_{H}$</td>
</tr>
<tr>
<td>11 Growth of $X_{AMR}$</td>
<td>$\mu_{AMR} \times \left( \frac{X_{AMR}}{K_{GS} + X_{AMR}} \right) \times \left( \frac{X_{AMR}}{X_{AMR} + X_{AMR}} \right) \times \left( \frac{X_{AMR}}{X_{AMR} + X_{AMR}} \right) \times \left( \frac{X_{AMR}}{X_{AMR} + X_{AMR}} \right) \times X_{AMR}$</td>
</tr>
<tr>
<td>12 Lysis of $X_{AMR}$</td>
<td>$b_{AMR} \times X_{AMR}$</td>
</tr>
<tr>
<td>13 Growth of $X_{ASRB}$</td>
<td>$\mu_{ASRB} \times \left( \frac{X_{ASRB}}{K_{GS} + X_{ASRB}} \right) \times \left( \frac{X_{ASRB}}{X_{ASRB} + X_{ASRB}} \right) \times \left( \frac{X_{ASRB}}{X_{ASRB} + X_{ASRB}} \right) \times \left( \frac{X_{ASRB}}{X_{ASRB} + X_{ASRB}} \right) \times X_{ASRB}$</td>
</tr>
<tr>
<td>14 Lysis of $X_{ASRB}$</td>
<td>$b_{ASRB} \times X_{ASRB}$</td>
</tr>
<tr>
<td>15 Aerobic growth of $X_{SOB}$ on $S_{OH}$</td>
<td>$\mu_{SOB} \times \left( \frac{X_{SOB}}{K_{GS} + X_{SOB}} \right) \times \left( \frac{X_{SOB}}{X_{SOB} + X_{SOB}} \right) \times \left( \frac{X_{SOB}}{X_{SOB} + X_{SOB}} \right) \times \left( \frac{X_{SOB}}{X_{SOB} + X_{SOB}} \right) \times X_{SOB}$</td>
</tr>
<tr>
<td>16 Anoxic growth of $X_{SOB}$ on $S_{OH}$</td>
<td>$n_{SOB} \times \mu_{SOB} \times \left( \frac{X_{SOB}}{K_{GS} + X_{SOB}} \right) \times \left( \frac{X_{SOB}}{X_{SOB} + X_{SOB}} \right) \times \left( \frac{X_{SOB}}{X_{SOB} + X_{SOB}} \right) \times \left( \frac{X_{SOB}}{X_{SOB} + X_{SOB}} \right) \times X_{SOB}$</td>
</tr>
<tr>
<td>17 Lysis of $X_{SOB}$</td>
<td>$b_{SOB} \times X_{SOB}$</td>
</tr>
</tbody>
</table>
Research topics

- Carbon footprint and Life Cycle Analysis (LCA)

![Bar chart showing carbon footprint (CF) for different LCA categories: Resources consumed, Transport, central market (Bcn), Transport, local supermarket, Waste management. The chart illustrates the CF in kg CO₂ eq./FU for L1, L2, L3, and L4.]
Facilities

- **Physico-chemical lab**
  - Water quality analysis
  - NTK detector (Selecta PRO-NITRO A)
  - Spectrophotometer (Spectronic INC, SPECTRONIC SYS8)
  - Ionic Cromatograph (DIONEX ICS 1000)
  - Gas Chromatograph (Thermo Finnigan Trace GC)
    - TDC
  - Gas Chromatograph (Agilent Tech 7820A)
    - 1 FID
    - 1 micro ECD

- **Processes engineering lab**
Facilities

- Pilot plants: constructed wetlands

Wastewater treatment

Sludge treatment
Facilities

- Pilot plants

High rate algal ponds

Photobioreactor
Facilities

- Pilot plants: anaerobic digestion for biogas generation
Ongoing research projects

- Design criteria and new configurations of constructed wetlands for conventional and emerging pollutants removal from wastewater – Spanish Ministry of Innovation and Science
- Drying reed beds for sludge treatment: assessment of process performance, design and operation criteria – Spanish Ministry of Environment
- Integrated solution for sewage and sludge treatment in small communities by means of constructed wetlands systems – Spanish Ministry of Environment
- Sustainable biomass-based energy systems in rural areas of Andean Countries – Catalan Government
Starting projects

- Application of microbial fuel cells in constructed wetlands – Spanish Ministry of Innovation and Science

- Biogas production from algae biomass produced in high rate ponds for wastewater treatment – Spanish Ministry of Innovation and Science

- Biotechnology for Africa’s sustainable water supply – FP7 European Commission
Possible collaboration lines

- Natural systems for wastewater and sludge treatment
- Water efficiency, treatment and reuse
- Mathematical modelling of biotechnologies
- Algae production
- Biogas production
- Life Cycle Assessment
Thanks for your attention

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Our web site:
http://gemma.upc.edu