VULnerability of hydro-systems to combined effect of Climate changes and human Activities in Mediterranean area

5th HYMEX Workshop

17 – 19 may 2011 – Punta Prima MENORCA

http://agire.brgm.fr/VULCAIN.htm
Objectives

- Water demand evolution
- Climate evolution

Exposition to hazard

Vulnerability

- Sensitivity to hazard
- Sensitivity of rivers and aquifers to climate and water demand → deficits (IPCC, 2001)

Adaptation potential

- Solutions to close the Resources to water demand budget

(5th HYMEX Workshop
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The study zone

Pyrénées Orientales department (4200 km²)
2 periods:
short-term (2020-40)
mid-term (2040-60)
Results

Non-stationarity of the present climate (1970 – 2006)

→ significant increase of the yearly temperatures:
  • mean over the study zone: +0.3 °C/10 year
  • more intense in mountainous than coastal context and for spring
→ significant increase of annual PET in mountainous context:
  • mean over the study zone: +1 à +4 mm/year
  • more intense during spring
→ non significant tendency for annual rainfall:
  • decrease in june and increase in november

Climate scenarios (2020-40 et 2040-60)

5 GCM (AR4 / SRES A1B):
- IPSL-CM4 (FR)
- CNRM-CM3 (FR)
- UKMO-HadGEM1 (GB)
- NCAR-CCSM3.0 (USA)
- MPI-ECHAM5 (D)

\[
\delta T = T_{\text{Future}} - T_{\text{Present}}
\]
\[
\delta P = \frac{P_{\text{Future}} - P_{\text{Present}}}{P_{\text{Present}}}
\]
Drinking-water demand: retrospective and prospective analysis

Simple DW model + Local water manager workshops

DW demand 2030:

[-9% ; +25%]

Uncertainties:

- Population
- Network efficiency
- Water saving / wasting
- Tourism
Results

Irrigation WD: retrospective and prospective analysis

Without considering climate change:

$$\sum_{j} \max \{0, (Kc(i, j) \times ETP(k, j) - P(k, j)) - RU(j - 1)\}$$

(Allen et al. 1998 (FAO))

Application of the « La Bussière » scenarios to the territory

Highly competitive agriculture

2030: -13%

Dual agriculture

Regionally-supported agriculture

2030: +18%

High performance environmental agriculture

Irrigation WD: retrospective and prospective analysis

Without considering climate change:

$$\sum_{j} \max \{0, (Kc(i, j) \times ETP(k, j) - P(k, j)) - RU(j - 1)\}$$

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Application of the « La Bussière » scenarios to the territory

Highly competitive agriculture

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Irrigation WD retrospective et prospective

Considering climate change:

\[ \sum_j \max [0, (K_c(i, j) \times ETP(k, j) - P(k, j) - RU(j - 1))] \]

(Allen et al. 1998 (FAO))

Results

Future demand
+ 10% (2020-40)
+ 27% (2040-60)

(Maton et al., en cours de soumission)

Specific climate indexes (frost, T>35°C, wind, ...)

CC impact and adaptation of agriculture (Aquimed project)

Bibliographic review

Adaptation workshop

External forcings → CC Impact on competing agriculture?

Solutions to the future water scarcity?
Climate change impact on water resources

**Results**

**Ground water:**
- Alluvial → moderate CC impact but not sufficient
- Karst → recharge through river losses reduction
- Captive → influence of withdrawal stronger than CC

**2020-40:**
- -10% to -20%
  - Spring and autumn

**2040-60:**
- -20% to -40%
  - All seasons
Vulnerability of the territory to Global Change

Results

Business-as-usual WD scenarios:

<table>
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<th>Tech 2</th>
<th>1980-2000</th>
<th>2020-40</th>
<th>2040-60</th>
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<tbody>
<tr>
<td>F dépassmt (%)</td>
<td>30.7</td>
<td>33.0</td>
<td>38.6</td>
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<tr>
<td>V déficit (Mm3)</td>
<td>5.10</td>
<td>6.24</td>
<td>7.88</td>
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</table>

Considering WD scenarios:

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</thead>
<tbody>
<tr>
<td>F dépassmt (%)</td>
<td>60.2</td>
<td>62.7</td>
<td>58.9</td>
<td>60.9</td>
<td>59.5</td>
<td>61.6</td>
<td>61.6</td>
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<tr>
<td>V déficit (Mm3)</td>
<td>6.24</td>
<td>6.69</td>
<td>7.83</td>
<td>6.28</td>
<td>7.38</td>
<td>6.49</td>
<td>7.61</td>
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</tbody>
</table>

New water resources/management needed?

+ 20%  
+ 50%
Conclusions

Future increase of T and PET coherent with that observed in the last 30 years

Decrease of precipitation for the mid-term

Water demand will probably increase slightly, while uncertain

Vulnerability of the territory mainly depends on CC, even for the short-term

doctorates

Climate: specific indexes are needed for practitioners

Captive aquifers: transitory simulations are needed – interannual inertia

Aquifers: deficit $\rightarrow$ sea-water intrusions?
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