WANDEL
Case study IV Drâa Valley, Morocco

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WANDEL
Local and regional level – Case studies

Concentrated Solar Power (CSP)
Einzugsgebiet
Drâa-Valley (Marokko)

Biomass

Large-Scale Hydro Power
Einzugsgebiet
Ober- und Mittelweser (Deutschland)

Coal
Einzugsgebiet
Obere Donau (Deutschland)
“In research, politics and industry the issue of water conservation is a key challenge in order to promote the acceptance and further implementation of CSP technology.”

(Source: Lilliestam et al. 2017)  
(Source: Greenpeace 2016)
Concentrated Solar Power (CSP)
Average water demand of CSP power plants with water cooling (%) and forecast of average water demand at Noor I – CSP Plant in Ouarzazate

Operation: 3.5 m³/ MWh

Construction: 1,875 m³/ MW

(Mirror cleaning (2-6%))

(Cooling processes (90-95%))

Other uses & Losses (1.5-4%)

(Data source: Report SocialCSP 2015)
Research area
Drâa Valley and Ouarzazate

(Source: Karmaoui et al. 2014)
Share of water uses Mansour Eddahbi reservoir

- Agriculture: 96%
- Households Ouarzazate: 2.2%
- Tourism: 0.9%
- CSP power plant: 0.8%

(Sources: Heidecke 2009; Busche 2012; Social CSP 2015, Karmaoui et al. 2016)
Water supply scenarios
Climate change scenarios temperature and precipitation trends in the region of the Drâa Valley

Temperature and precipitation trends from REMO compared to baseline 1978-2007

(Source: Busche 2012)
Water supply scenarios
Water availability “Mansour Eddahbi” reservoir under consideration of climate change scenarios

Diekkrüger et al. (2010):
Scenario development

**Water supply**
Future water supply considering climate change impacts
→ **Water resource scenarios:**
(data based on climate change scenarios)

**Water demand**
Future development with regard to socio-economic pathways and technologies
→ **Water demand scenarios:**
(Scenario development and validation together with local stakeholders)

Scenario combinations

Critical combinations?
Measures to avoid critical scenarios

Measures with focus on energy

Technological options to reduce the water consumption of the power plant

Measures with focus on water

Sectorial options to reduce the water consumptions in sectors such as agriculture etc.

Criteria for assessment of measures

Multi-criteria assessment of measures

Preferred measures
Development of potential solutions

Assessment approach
Ranging from the regulatory framework and governance systems respectively

Framework
Regulatory framework, social and political context

Identification and discussion
Potential solutions for addressing challenges in middle and long-term (participative modelling)

Implementation
Institutional innovations and implementation plan

Derivation of conceptual framework
Systematization of developed approaches and methods for transferability to further regions with similar challenges
Identifying factors influencing the water demand
System mapping based on literature review
## Identifying critical links
Overview links influencing the water demand and use

<table>
<thead>
<tr>
<th>Agriculture developments</th>
<th>Social developments</th>
<th>Economic &amp; infrastructure developments</th>
<th>Policy framework</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivated area</td>
<td>Population development (oasis/towns)</td>
<td>Tourism sector development</td>
<td>Subsidies and support programs</td>
</tr>
<tr>
<td>Choice of crop types</td>
<td>Lifestyle developments</td>
<td>Industry sector development</td>
<td></td>
</tr>
<tr>
<td>Irrigation with groundwater</td>
<td>Food production</td>
<td>Economic development</td>
<td></td>
</tr>
<tr>
<td>Irrigation efficiency</td>
<td></td>
<td>Transport infrastructure development</td>
<td></td>
</tr>
<tr>
<td>Livestock numbers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water quality</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Key factor analysis
Discussion of potential future developments of key factors

(Source: MENARES 2018)
### Scenario storylines

#### Overview

<table>
<thead>
<tr>
<th>S1</th>
<th>S2</th>
<th>S3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Business as usual</strong></td>
<td><strong>Economic growth first</strong></td>
<td><strong>Growing sustainability</strong></td>
</tr>
<tr>
<td>A scenario that assumes there will be <strong>no significant changes to current water use patterns</strong> in agriculture and no major changes in water use technologies. People’s priorities remain the same and no major changes in policies occur.</td>
<td>A scenario that assumes the <strong>exploitation of water resources to foster rural development</strong>. Focus on cash crop production and modern technologies promise short-term economic benefits until water resources are exhausted.</td>
<td>A scenario that assumes a development which stays within the <strong>sustainable limits of the available water resources</strong> by applying various water conservation and efficiency measures. Strong commitment by population to avert a water crisis.</td>
</tr>
</tbody>
</table>
Scenario storylines
Quantification of water demand scenarios for 3 different storylines
2nd Workshop Ouarzazate
Evaluating measures to address water challenges

1. Discuss criteria to evaluate measures

2. Define decision preferences

3. Discuss measures to address water challenges

Decisions on water resources
Evaluation criteria
Criteria overview and relevant factors for measures

- **Sustainability criteria**
  - **Environmental**
    - Water savings
    - Water quality
    - Sustainability of water use
  - **Technology**
    - Technical & operational suitability
  - **Economic**
    - Investment costs
    - Operational costs
    - Economic benefit
  - **Social**
    - Social acceptance
Evaluation Criteria
Criteria weighting

Farmers

- C1 Water savings: 35%
- C3 Sustainability of water use: 15%
- C5 Investment cost: 11%
- C7 Economic benefit: 21%
- C2 Water quality: 8%
- C4 Technical and operational suitability: 3%
- C6 Operation & maintenance costs: 2%
- C8 Social acceptance: 5%

Administration

- C1 Water savings: 35%
- C3 Sustainability of water use: 15%
- C5 Investment cost: 11%
- C7 Economic benefit: 21%
- C2 Water quality: 8%
- C4 Technical and operational suitability: 3%
- C6 Operation & maintenance costs: 2%
- C8 Social acceptance: 5%

Civil society group

- C1 Water savings: 35%
- C3 Sustainability of water use: 15%
- C5 Investment cost: 11%
- C7 Economic benefit: 21%
- C2 Water quality: 8%
- C4 Technical and operational suitability: 3%
- C6 Operation & maintenance costs: 2%
- C8 Social acceptance: 5%
Water saving measures
Categories of the measures

Water conservation
Measures aiming at the conservation of water sources and thereby the increase of available water

Water efficiency
Measures aiming at efficient water use, for example by applying modern technology

Water policy
Measures aiming at increasing the attractiveness of water efficient and conserving behaviour and technologies

Energy technology measures
Measures aiming at increasing the attractiveness of water efficient and conserving behaviour and technologies
Evaluation of measures to address water challenges
Results Multi criteria-analysis (MCA)

Most recommendable alternatives

M1 Crop choice
M2 Irrigation practices
M3 Irrigation efficiency
M4 Conveyance efficiency
M5 Precision agriculture

Average weighting

- C1 Water savings
- C2 Water quality
- C3 Sustainability of water use
- C4 Technical and/or operational suitability
- C5 Investment cost
- C6 O&M costs
- C7 Economic benefits
- C8 Social acceptance
Evaluation of measures to address water challenges
Results Multi criteria-analysis (MCA)

Most recommendable alternatives

M1 Crop choice
M3 Irrigation efficiency
M4 Conveyance efficiency
M5 Precision agriculture

50% weight on water saving
### Evaluation of measures to address water challenges

#### Results

Multi criteria-analysis (MCA)

<table>
<thead>
<tr>
<th>Most recommendable alternatives</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1 Crop choice</td>
<td>4</td>
</tr>
<tr>
<td>M2 Irrigation practices</td>
<td>4</td>
</tr>
<tr>
<td>M3 Irrigation efficiency</td>
<td>4</td>
</tr>
<tr>
<td>M4 Conveyance efficiency</td>
<td>5</td>
</tr>
<tr>
<td>M5 Precision agriculture</td>
<td>3</td>
</tr>
<tr>
<td>M7 Wastewater treatment</td>
<td>1</td>
</tr>
<tr>
<td>M11 Aligning the national water and agriculture strategies</td>
<td>1</td>
</tr>
</tbody>
</table>

- These measures are evaluated to be preferable, regardless of the weighting-set applied, and all of them focus on the agricultural sector.

- Technological adaptations in the solar thermal power plants, on the other hand, are less advantageous alternatives.
3rd Workshop Ouarzazate
Evaluating governance concepts to address water challenges

1. Discuss governance strategies

2. Define governance concepts

3. Discuss implementation of selected water saving measures
Solution strategies
Evaluating opinion and attitude of stakeholders to address water stress reduction strategies

**Overall objective**
Debate between stakeholders and multi-stakeholder understanding

**Ranking strategies**
In different group discussions strategies are ranked conform the implementation on the respective measures

**Consensus finding**
- Targeted training and information of citizens is the first step towards introducing water saving measures
- Assistance in implementing technical solutions as prerequisite
- Combining measures from other regions of the world with traditional working methods to counteract water scarcity
Conclusion
Capacity building in the context of the Water-Energy-Nexus

- Interdisciplinary research is needed to address the Water-Energy-Nexus at different levels and to consider relevant stakeholders

- Participatory approach resulted in substantial learning effect
  - Long-term thinking
  - Dynamic thinking
  - Multi-criteria assessment

- Local workshops contribute to horizon awareness for environmental conservation topics

- Capacity building and bringing different stakeholder together result in high acceptability of implemented measures and strategies
Thank you very much for your attention!

For further information, please visit
www.wupperinst.org
http://wandel.cesr.de/de