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Development of high resolution hydro-climatic modelling to support adaptation of water, energy and agriculture in the Middle-East

Stéphane Simonet, Managing Director, ACTERRA,
s.simonet@acterraconsult.com

Mufleh Abbadi, Water and Climate Change Regional Programme,
IUCN ROWA, Mufleh.ABBADI@iucn.org

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Context

- **Middle-East is a global climate change hotspot, with wide ranging implications for key development sectors and water security**
- **Common needs to enhance scientific knowledge and information on climate change impacts in order to improve development planning and water management decisions**

2014

Third National Communication of Jordan

High resolution climate projections using CORDEX and Vulnerability assessment

2015-2017

EXACT Programme - Fostering Co-operation on Water Management between the Palestinian, Israeli, and Jordanian Water Authorities

High resolution hydro-climate model

Activities

1. **Develop a high-resolution climate projection dataset (25 – 5 km) using dynamical downscaling (CORDEX and WRF) to support assessment of CCI on water resources**
2. **Capacity building & institutional strengthening program to help the countries in using and sustaining the climate dataset for their adaptation studies**
3. **Develop an web-based climate information portal to facilitate the visualization and extraction of the data.**

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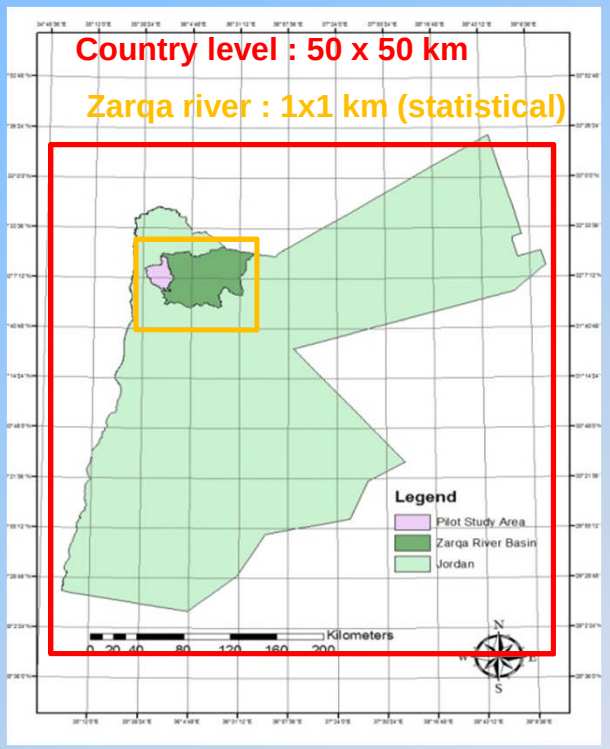
Downscaling of climatic indices

A set of key climate indices

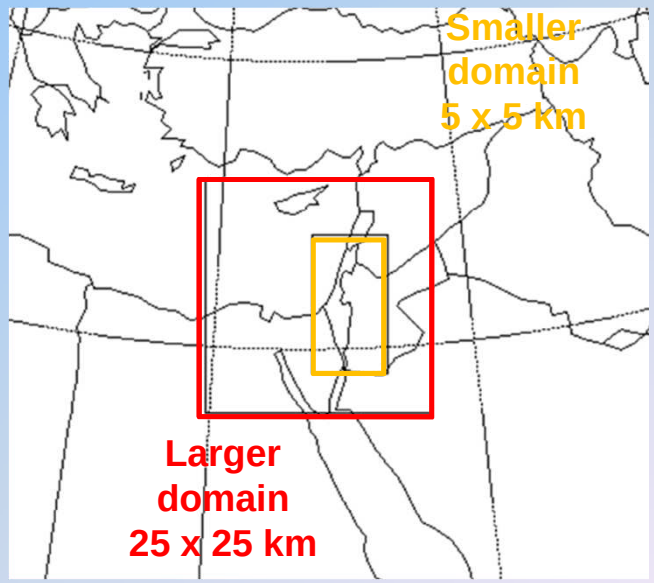
- Mean Temperature
- Maximum Temperature
- Minimum Temperature
- Total Precipitation
- Potential Evapotranspiration
- Mean of daily relative humidity
- 6-month Standardized Precipitation Index
- 3-month Standardized Precipitation Index
- Heavy precipitation
- Maximum no of consecutive dry days
- Wind speed and direction

Downscaled for various spatial scales

Jordan TNC (2014)



EXACT Programme (2016)



3 pilot sub-basins:

- Maleh shobash
- W. Zarqa River
- E. Gilboa Hills

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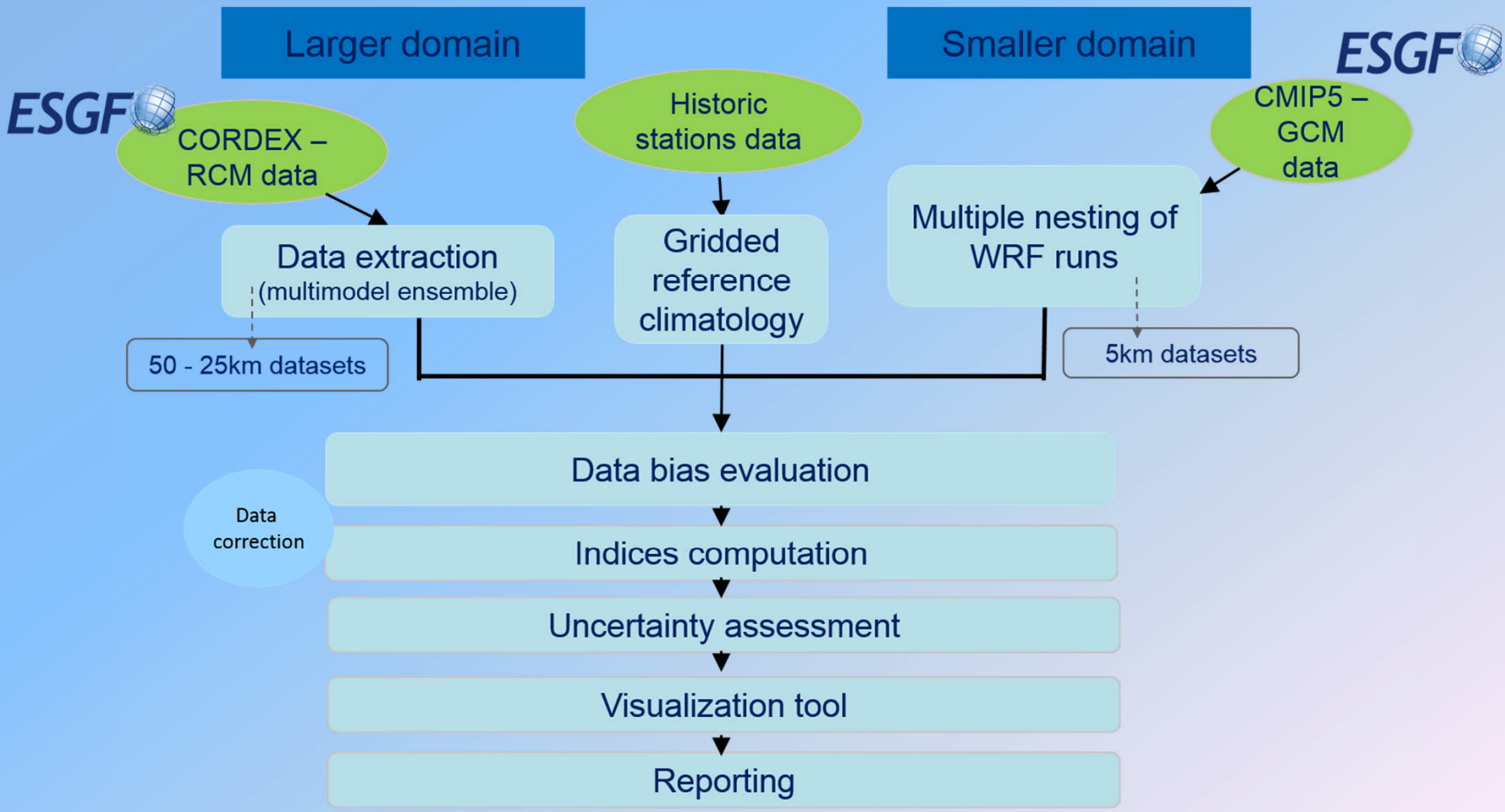
Overall workflow



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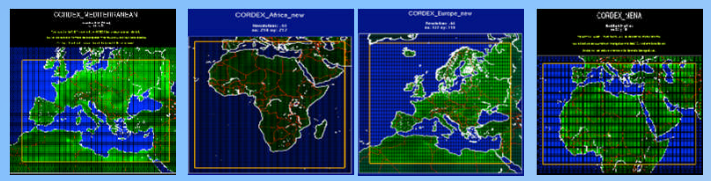
Modelling approach

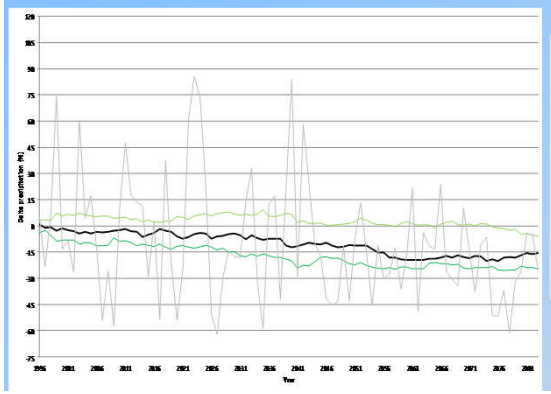
Larger domain (CORDEX)

- 2 socio-economic scenarios (RCP 4.5 and 8.5)
- Time horizon 2015-2100 (Y, M, D)
- Reference period : 1981-2010
- Choice of one CORDEX domain
- Use of several couples GCM-RCM (up to 14 for AFRICA Cordex)

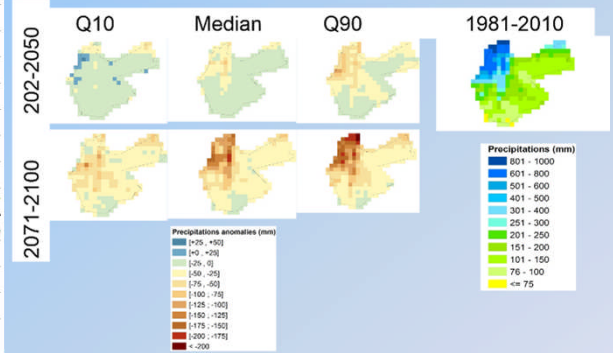


http://wcrp-cordex.ipsl.jussieu.fr/

- Generation of multimodel ensemble and maps

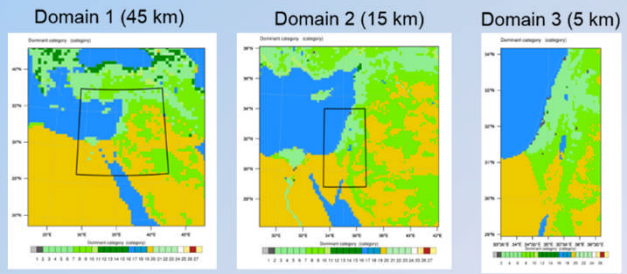


Results : a drier climate – RCP 8.5



Smaller domain (WRF)

- 2 socio-economic scenarios (RCP 4.5 and 8.5)
- Time horizon 2015-2050 (Y, M, D, H)
- Reference period : 1981-2010
- 2 CMIP5 models : IPSL (France) and NOAA (USA)
- WRF downscaled with 3 nested domains : 45 km → 15 km → 5 km



CPU >250 000h
30 Terabytes of data !

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Regional Climate Information Portal

Importance of good visualization charts and interesting indicators. The main purpose is to deliver and transfer an information that is : Relevant, Usable, Credible

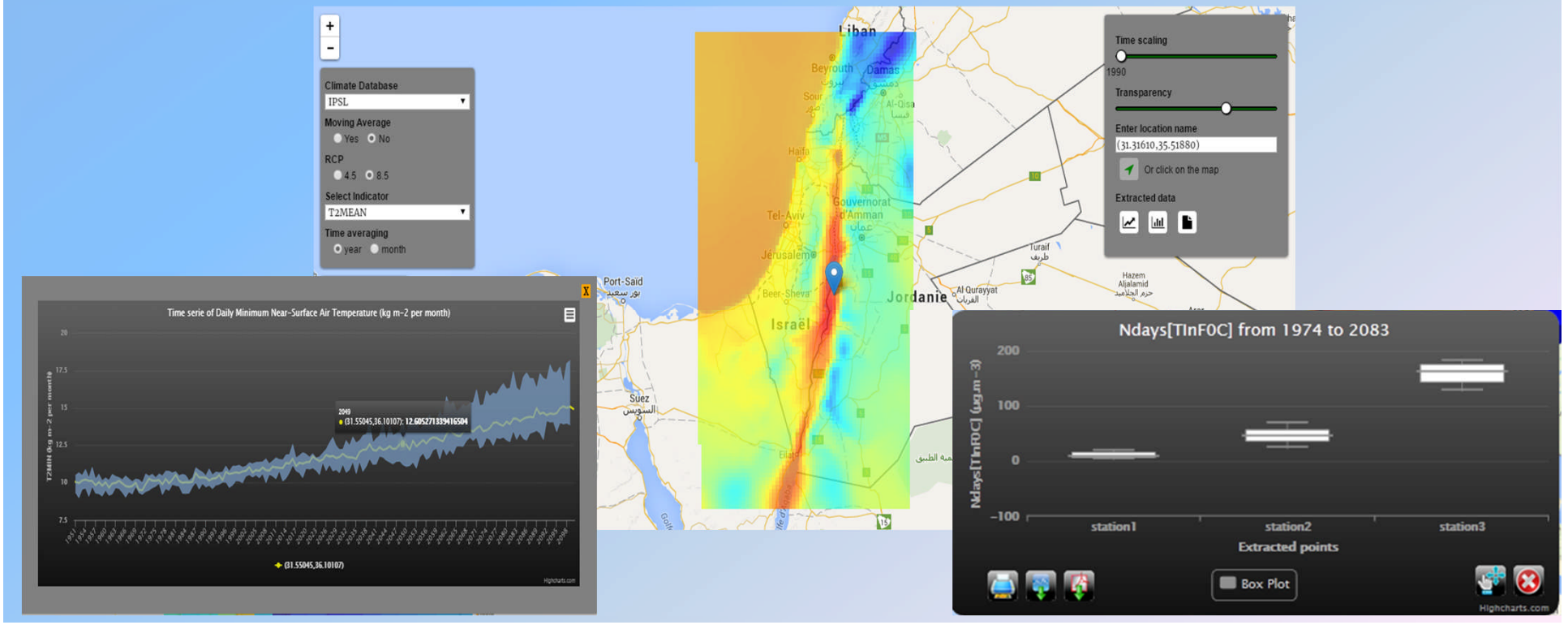
Maps, Time series, box plot, Taylor diagram…

Delivery of a user friendly web portal:

Based on the web/GIS technologies

Tailored to the user needs:

- Regions, indices
- Functionalities



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Climate change summary - Jordan

Trend	Details
A Warmer Climate	All models converge to increase in temperature. In 2070-2100, average temperature increase could reach for RCP 4.5, +2,1°C [+1,7 to +3,2°C], and +4°C [3,8- 5,5°C] for RCP 8.5
A Drier Climate	In 2070-2100, the cumulated precipitation could decrease by 15% [-6% to -25%] in RCP 4.5, by – 21% [-9% to -35%] in RCP 8.5. The decrease would be more marked in the western part of the country
Warmer Summer, drier autumn and winter	The warming would be more important in summer, and the reduction of precipitation more important in autumn and winter than in spring, with for instance median value of precipitation decrease reaching -35% in autumn in 2070-2100
More Heat Waves	The analysis of summer temperature, monthly values and the inter-annual variability reveal that some thresholds could be exceeded. For instance, in pessimistic but possible projections, for a summer month, the average of maximum temperature for the whole country could exceed 42-44°C.
More Droughts	The maximum number of consecutive dry days, evaporation, and SPI analyses indicated increase. The occurrence of snow would strongly decrease. This will complicate water management.
Intense Precipitations	The number of days with heavy rain (>10 mn) may exist but not on a regional scale and thus did not evolve significantly,

Highly Confidence	Moderate Confidence	Low Confidence

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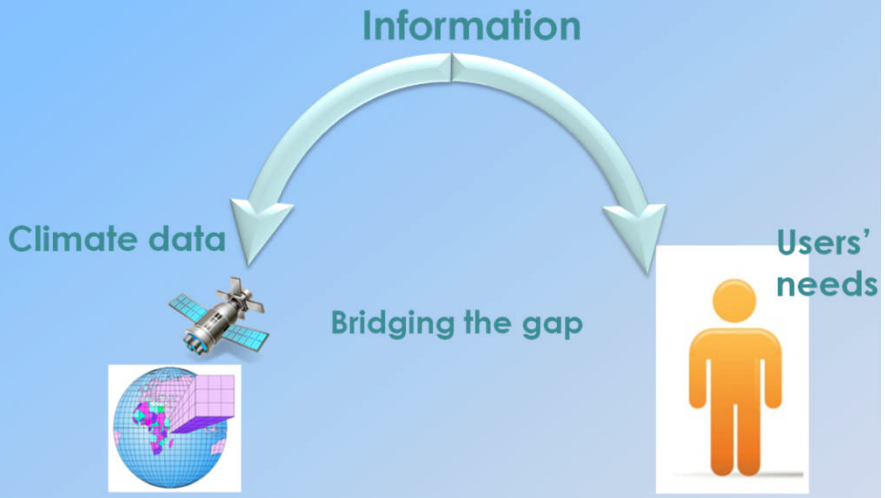
Capacity building

- **A ‘’climate service’’ approach**
  - **Connecting the providers and users of climate information**
  - **Easing access to and use of climate data**
- **Targets two major groups:**
  - **Supply group (climatologists, hydrologists)**
  - **Demand group (water modelers and managers)**
- **Two main focuses:**
  - **Downscaled data generation, administration and updating**
  - **Data use and application for hydrological impact modelling and adaptation planning**
- **2 international training courses**
  - **2015 : Amman (Jordan) : Staff of MoE and Met Office → CORDEX**
  - **2016 : Toulouse (France – ENM/Meteo France): 15 staff from Met offices and Water Authorities from Israel, Jordan and Palestine**
- **Guidance materials**



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Added-value and innovativeness

- **New approach for future projections is implemented based on Coupled Model Intercomparison Project Phase 5 (CMIP5) and Regional CORDEX Database**
- **Implementation for the first time in the region of the meso-scale climate model WRF coupled with GCM, delivering daily and hourly data**
- **Used of sophisticated data correction techniques, based on long and verified historical data - Uncertainty levels were assessed.**
- **Cutting-edge geo-statistical techniques applied to generate high resolution gridded climatology and further statistical downscaling**
- **Real recommendations for decision makers (include ranges of future projections).**
- **Tackled many indices, identified through a user-driven process**
- **Regional climate information portal for data visualization and extraction**
- **Need-driven short term and long term capacity building programme**
- **Regional cooperation around common issues and needs amongst technical staff**

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Integrated Vulnerability Assessment and Adaptation Planning

WATER

River runoff
Groundwater level
Water availability
Water demands
Extreme events

Hydrological modeling

ENERGY

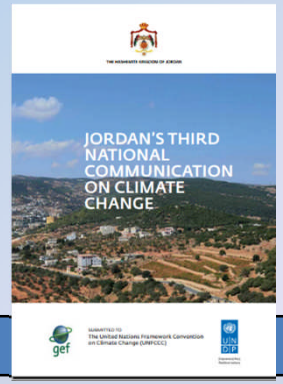
Power production
Peak demand
Dam management
Extreme events

FOOD

Agro-ecological zones
Irrigation needs
Crop yields
Crop suitability
Drought management

Vulnerability and risk assessment

Adaptive capacity		Impact					
	Score	Score	0,1-1	1,1 - 2	2,1 - 3	3,1 - 4	4,1 - 5
	Score	Description	Very low	Low	Moderate	High	Very high
	0,1 – 1	Very low	Moderate	Moderate	Moderate	Very high	Very high
	1,1 – 2	Low	Low	Moderate	Moderate	High	Very high
	2,1 – 3	Moderate	Low	Moderate	Moderate	High	Very high
	3,1 – 4	High	Very low	Low	Moderate	Moderate	High
	4,1 - 5	Very high	Very low	Low	Low	Moderate	High



Adaptation planning

Climate change hazards	Resulting risks	vulnerability assessment	Sector-specific adaptation measures	WEF Adaptation Measures
Reduced precipitation and increase temperature	Degradation of the ground water (quantity and quality) due to high water and energy use which increase life cost due to the unwisely use of ground water and energy .	**High**	• Conjunctive use • Wastewater treatment • Rainwater harvesting • Water saving devices • Decentralized wastewater treatment	• **Reduce abstraction by Investigating new and modern agricultural technologies that consume less water and energy such as hydroponic production, solar soil sterilization and solar food drying and using solar energy pumping system** • **Utilizing brackish water and use solar desalination plants** • **Using solar water heating system , efficient energy use machines .** • **Increase water use efficiency at farm level and improve the friendly environmentally practices, which will reflect positively on food security, improvement of the livelihoods and environment situations in the area and low GHG emission**

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Merci de votre attention

Thank you for your attention

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