SUSTAINABLE DEVELOPMENT, CLIMATE CHANGE AND MEDITERRANEAN AREA: A WATER-ENERGY-FOOD-ECOSYSTEM NEXUS APPROACH

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Summary of key risks for the Mediterranean basin

CLIMATE-RELATED DRIVERS

By 2040, mean temperature will be 2.2°C above pre-industrial levels. Per 1°C warming, rainfall will decrease 4%. Sea level could rise by more than 90 cm by 2100.

NON CLIMATE-RELATED DRIVERS

- Air and water pollution increase overall.
- Urbanization & land degradation reduce agricultural land.
- Overfishing & non-indigenous species threaten marine biodiversity.

The Mediterranean region is warming 20% faster than the global average.

Regional temperature increase of 2.2°C by 2040 with current policies. Paris Agreement’s target of 1.5°C.

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HEALTH AND SECURITY
Increase in frequency, intensity and duration of HEAT WAVES imply significant health risks for vulnerable populations, especially in cities.
Increasing frequency in droughts since the 1950s has played a significant role in the current regional crisis.

Conflicts concerning limited natural resources may increase large-scale human migrations.

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Sea level rises may exceed 1 metre by 2100, impacting 1/3 of the region's population. Half of the 20 global cities set to suffer most from sea level rises by 2050 are in the Mediterranean.

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Food demand is set to increase as yields of crops, fish and livestock decline. 90% of commercial fish stocks are already overfished, with the average maximum body weight of fish expected to shrink by up to half by 2050.

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**ECOSYSTEMS**

The Mediterranean basin is one of the most prominent hotspots of climate and environmental change. 700+ non-indigenous animal species recorded due to warmer conditions. Increasing water acidification causes mass deaths of marine species. Mega fires have destroyed record areas of forest due to climate change.

**HEALTH AND SECURITY**

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Addressing the risk in the Mediterranean Basin in a water-energy-food-ecosystem nexus
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Energy access:
08: Access to electricity (% of population)
09: Renewable energy consumption (% of total final energy consumption)
10: Renewable electricity output (% of total electricity output)
11: CO2 emissions (metric tons per capita)
Energy availability
12: Electric power consumption (kWh/capita)
13: Energy imports, net (% of energy use)

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Forest, biodiversity and pollution

Food access:
14: Prevalence of undernourishment (%)
15: Percentage of children under 5 years of age affected by wasting (%)
16: Percentage of children under 5 years of age who are stunted (%)
17: Prevalence of obesity in the adult population (18 years and older)

Food availability
18: Average protein supply (grams/capita/day)
19: Cereal yield (kg/hectare)
20: Average Dietary Energy Supply Adequacy (ADESA) (%)
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**Water access:**
- 01: The percentage of people using at least basic drinking water services (%)
- 02: The percentage of people using at least basic sanitation services (%)
- 03: Degree of WRM implementation (1-100)

**Water availability**
- 04: Annual freshwater withdrawals, total (% of internal resources)
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Clean water supply needs energy

Food production, processing and transport need energy

Fossil fuel extraction, energy crops and carbon sequestration impact on food supply

Energy production (including sequestration) needs water, and impacts on water quality and availability

Forest, biodiversity and pollution

Ecosystem pillar

Energy and food pillar

Food production needs clean water, and impacts on water quality and availability

Water infrastructure and use impacts on fish stocks, food supply and land use

Source: Simpson et al. (2022)
Addressing the risk in the Mediterranean Basin in a water-energy-food-ecosystem nexus

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- 06: Environmental flow requirements (10^6 m³/annum)
- 07: Average precipitation in depth (mm/annum)
1. Water and food pillars strongly correlated (~60%)
2. No significant correlation between water/food and energy pillars
3. Strong north-side divide

Dominating challenges faced by Mediterranean countries are water availability and a strong dependency on food and energy imports, with social and economic disparities across countries.
Water-energy-food-ecosystem nexus and sustainable development goals (SDGs)

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Source: Riccaboni et al. (2020)  
Bayoumi et al. (2022)  
Sachs et al. (2022)

SDG achievement, Challenges remain, Significant challenges, Major challenges, Unavailable data

Sources: Riccaboni et al. (2020)  
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**Sustainable Development Goal indicators**
Comparison between northern and southern Mediterranean countries

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Direction of axis reversed to harmonize direction towards goal.
This is the only indicator where southern Mediterranean countries are ahead.

Source: IPCC AR6 (2021)
Resource overexploitation is contributing to their rapid depletion and consequent environmental degradation, limiting success in reaching the Sustainable Development Goals (SDGs) in the Mediterranean countries.
Cascading impacts of drivers of change in the nexus

Drivers of change →

- **Water pillar**
  - Main drivers (107)
    - Climatic drivers
      - Air & water temperature
      - Droughts
    - Non climatic drivers
      - Water pollution
      - Population growth
      - Modernization

- **Energy pillar**
  - Main drivers (75)
    - Climatic drivers
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      - Droughts
    - Non climatic drivers
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      - Modernization
      - Mitigation policies

- **Food pillar**
  - Main drivers (107)
    - Climatic drivers
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      - Modernization
      - Lifestyle change
Cascading impacts of drivers of change in the nexus

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Cascading impacts of drivers of change in the nexus

Drivers of change →

1st level impact →

Water pillar
- Main drivers (107)
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    - Air & water temperature
    - Droughts
  - Non climatic drivers
    - Water pollution
    - Population growth
    - Modernization
- Pillar impact (107)
  - Access
    - Drinking water & sanitation
  - Availability
    - Freshwater withdrawals
    - Freshwater resources
    - Environ. flow requirements
    - Average precipitation

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    - Modernization
    - Mitigation policies
- Pillar impact (75)
  - Access
    - Electricity access
    - Renewable energy demand
    - Renewable energy output
    - CO₂ emissions
  - Availability
    - Electric power consumption
    - Energy imports

Food pillar
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  - Non climatic drivers
    - Water and soil pollution
    - Population growth
    - Modernization
    - Lifestyle change
- Pillar impact (107)
  - Access
    - Undernourishment
    - Obesity
  - Availability
    - Protein supply
    - Cereal yield
    - Dietary energy supply

Sign of change:
- Increasing trend
- No significant trend
- Decreasing trend

Amount of evidence:
- Limited evidence
- Medium evidence
- Robust evidence

Level of agreement or confidence:
- Low agreement or limited evidence
- Low
- Medium
- High
Cascading impacts of drivers of change in the nexus

Drivers of change → 1st level impact → Cascade in the WEFE nexus → Impact on the WEFE nexus

**Water pillar**
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    - Average precipitation
- Cascading on other pillars (36)
  - Access
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  - Availability
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  - Cereal yield

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    - Electricity access
    - Renewable energy demand
    - Renewable energy output
  - Availability
    - Electric power consumption
  - CO₂ emissions
- Cascading on other pillars (30)
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    - CO₂ emissions
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Cascading impacts of drivers of change in the nexus

Drivers of change → 1st level impact → Cascade in the WEF nexus → Impact on the WEF nexus

The cascade of drivers impacts has potentially a degrading trend in the nexus:
- one key lever of action is through the energy pillar
- Adaptation & mitigation solutions needed to maximize improvement of nexus impact
Implementing a nexus approach in the Mediterranean

Existing management response

Local experimentations
- Technological solutions
- Real or near-real-time digital services
- Ecosystem- and nature-based solutions
- Behavioural change and sobriety

Governance
- Union for the Mediterranean
- Center for Mediterranean Integration
- Global Water Partnership-Mediterranean
- Association of Agricultural Research Institutions in the Near East & North Africa

Funding
- Partnership for Research and Innovation in the Mediterranean Area
- MENA Regional Innovation Hub
Implementing a nexus approach in the Mediterranean

Technological solutions
• Alternative and more sustainable water irrigation techniques
• Use of renewable energy in agricultural and other sectors
• Desalination, often combined with power generation
• Non-conventional water resources and wastewater reuse
• Increase bio-energy crop production in marginal areas

Source: Toledo and Scognamiglio (2021)
Implementing a nexus approach in the Mediterranean

Technological solutions
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Real or near-real-time digital services
- Early warning systems
- Climate services

Source: Toledo and Scognamiglio (2021)

Source: Alvarez-Castro et al. (2023)
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Behavioural change
- Mediterranean diet and sobriety

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- Agroecosystems

Source: Alvarez-Castro et al. (2023)

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## Implementing a nexus approach in the Mediterranean

<table>
<thead>
<tr>
<th>WEFE nexus adaptation and mitigation strategies</th>
<th>Existing management responses in the Mediterranean basin</th>
<th>Water pillar (SDG 6)</th>
<th>Energy pillar (SDG 7)</th>
<th>Food pillar (SDG 2)</th>
<th>Ecosystem pillar (SDG 14 and 15)</th>
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- UN Agenda for Sustainable Development
- UN Framework Convention on Climate Change
- FAO Plans for Action
- Paris Agreement
- UN Desertification Convention
- Convention on Biological Diversity
- Common Agricultural Policy
- Common Fisheries Policy
- Climate Law
- Water Framework Directive
- United Water Strategy
- ARIMNET
- ERANETMED
- PRIMA
- MENA RIIH
Lack of concrete examples of global implementation of a nexus approach → many measures still designed in “silos” due to:

- insufficient understanding of nexus trade-offs amongst science-policy-stakeholder interactions
- insufficient incentives
- limited vision, knowledge, development and investment
- higher costs of nexus approaches than those of silo approaches, due to the information, expertise, time, coordination and financial resources required
Boosting local experimentation to global implementation: concept-to-implementation gap

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Actions to overcome the poor integration of nexus approach

Science found as a tool for overcoming the poor integration of nexus approach in the Mediterranean region

Actions and interventions needed to build institutional capacity which include:

- enhance finance mechanisms
- intra-regional dialogue between implementers of the nexus approach, policy makers, and the general public
- pilot nexus approaches through modeling and assessment
Thank you for your attention