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European research on climate change impact on Water and Adaptation

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European policies on Water and adaptation

- The European Union is equipped of a good series of directives and guidelines related to this subject:
  - The Water Framework Directive
    http://europa.eu/legislation_summaries/environment/water_protection_management/l28002b_en.htm
  - The Flood assessment and mgmt Directive
    http://europa.eu/legislation_summaries/environment/water_protection_management/l28174_en.htm
  - The Water Scarcity and Drought policy
    http://europa.eu/legislation_summaries/environment/water_protection_management/l28196_en.htm
  - The White Paper on Adaptation to Climate Change
    http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52009DC0147:EN:NOT
  - The guidance document on adaptation to climate change in Water Management
    http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents/management_finalpdf/_EN_1.0_&a=d

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Research is a key

- All the previously mentioned policies have been based on the best available knowledge
- Knowledge gaps are still very relevant, and they are addressed through the EU Framework Programme for Research
- About 800 M€ invested in Water research in the last ten years through various FPs
- FP7 (2007-2013) worth 55 billion€, of which about one third directly related with climate change and sustainability

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Importance of integration in water research

- Water is a cyclic resource
- It flows through different environmental "matrixes" (like atmosphere and soil) and forms different "bodies" (like rivers, lakes, wetlands, estuaries, seas, etc.) each having complex mechanisms and functions, and each presenting a mix of abiotic and biotic components
- It's cycle has been modified by human intervention since centuries, and it is an essential element for human economy
- All this makes the cause-effects relationships very complex to assess, being them the integrated result of several concurrent processes

Key issues for adaptation to climate change

- Water resources are globally impacted by climate change: higher temperatures increase the hydrological cycle
- In Europe, Global models show an expected increase of winter precipitations at northern latitudes and a decrease of summer precipitations at lower latitudes
- Models predict an increase of flood risk and of summer droughts
- Observations of recent trends do not always fit

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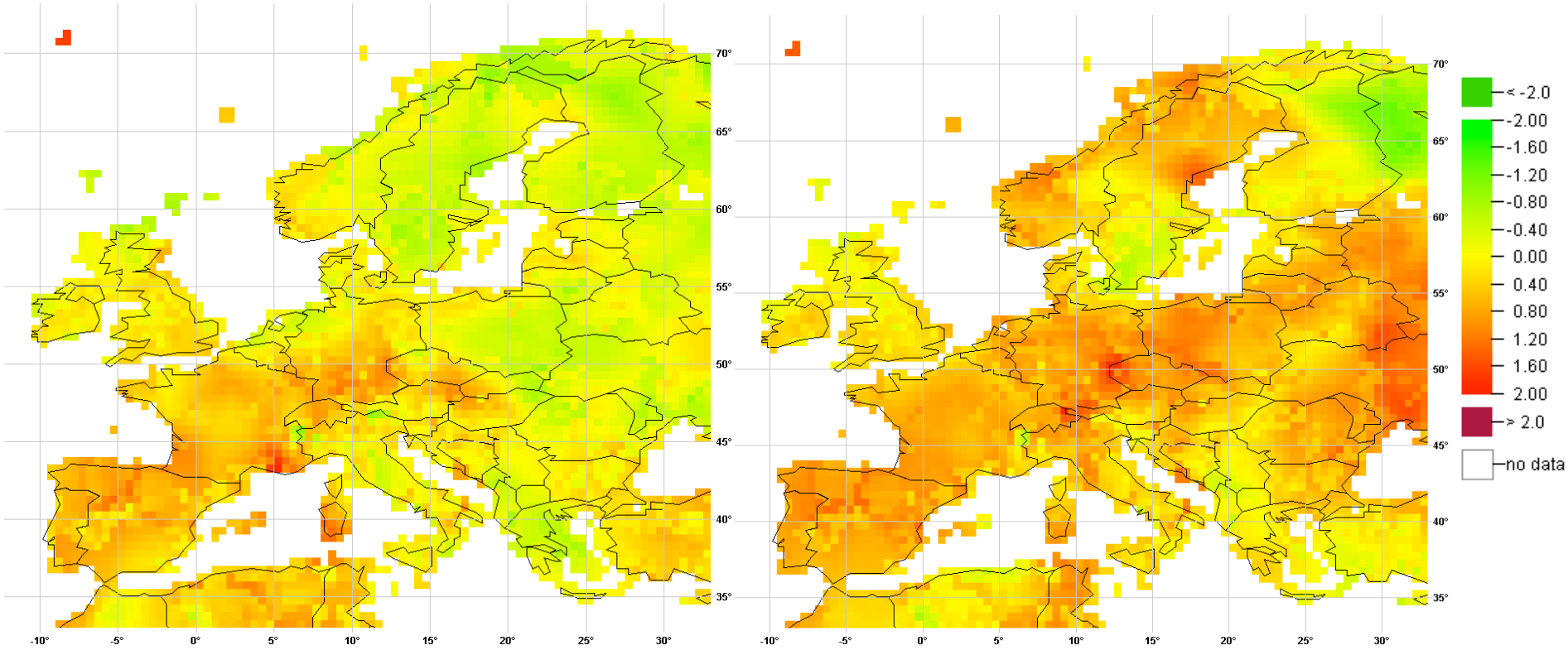
Change in temperature over the 20th century



summer **winter**

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Source: PIK database PixDAT (NeWater project)

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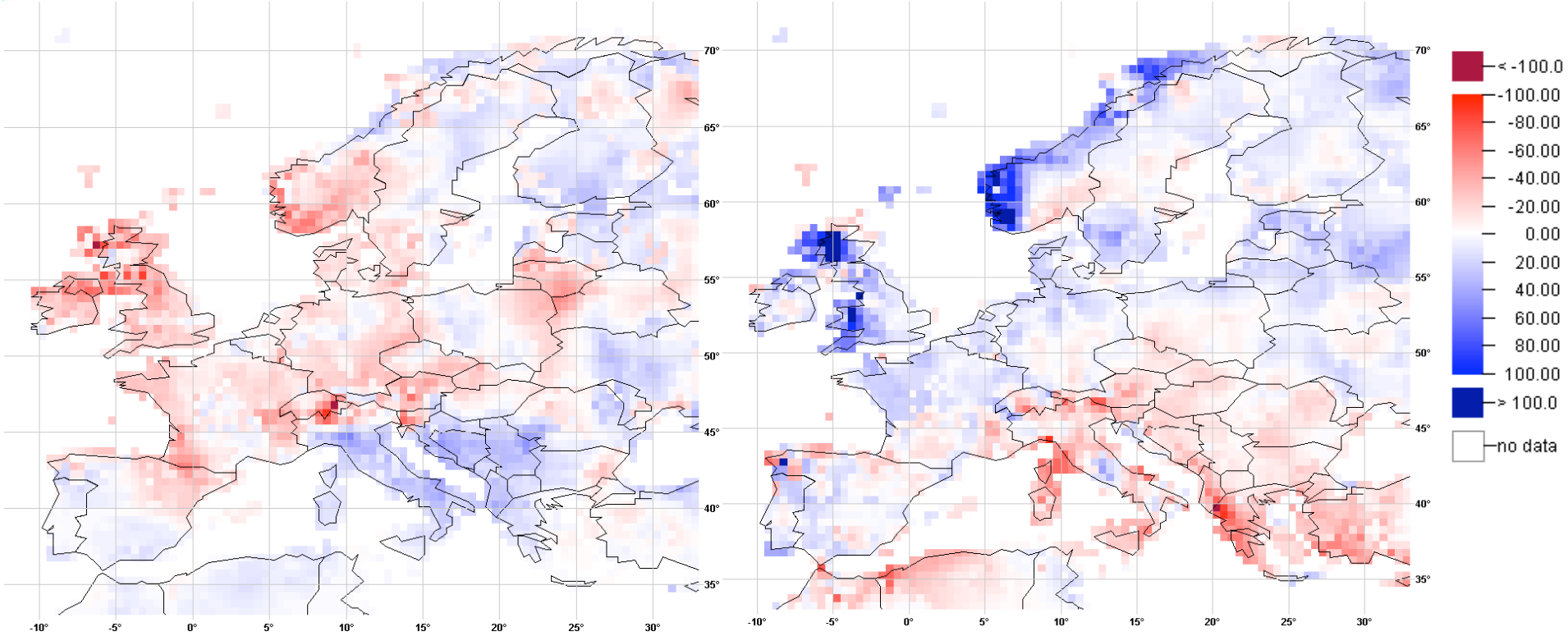
Change in precipitation over the 20th century



summer

winter

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However…

- The hydrological cycle may impact on climate change
- At local level, the hydrological cycle is mainly affected by water management and land use
- Complex feedback may lead to "unexpected" results

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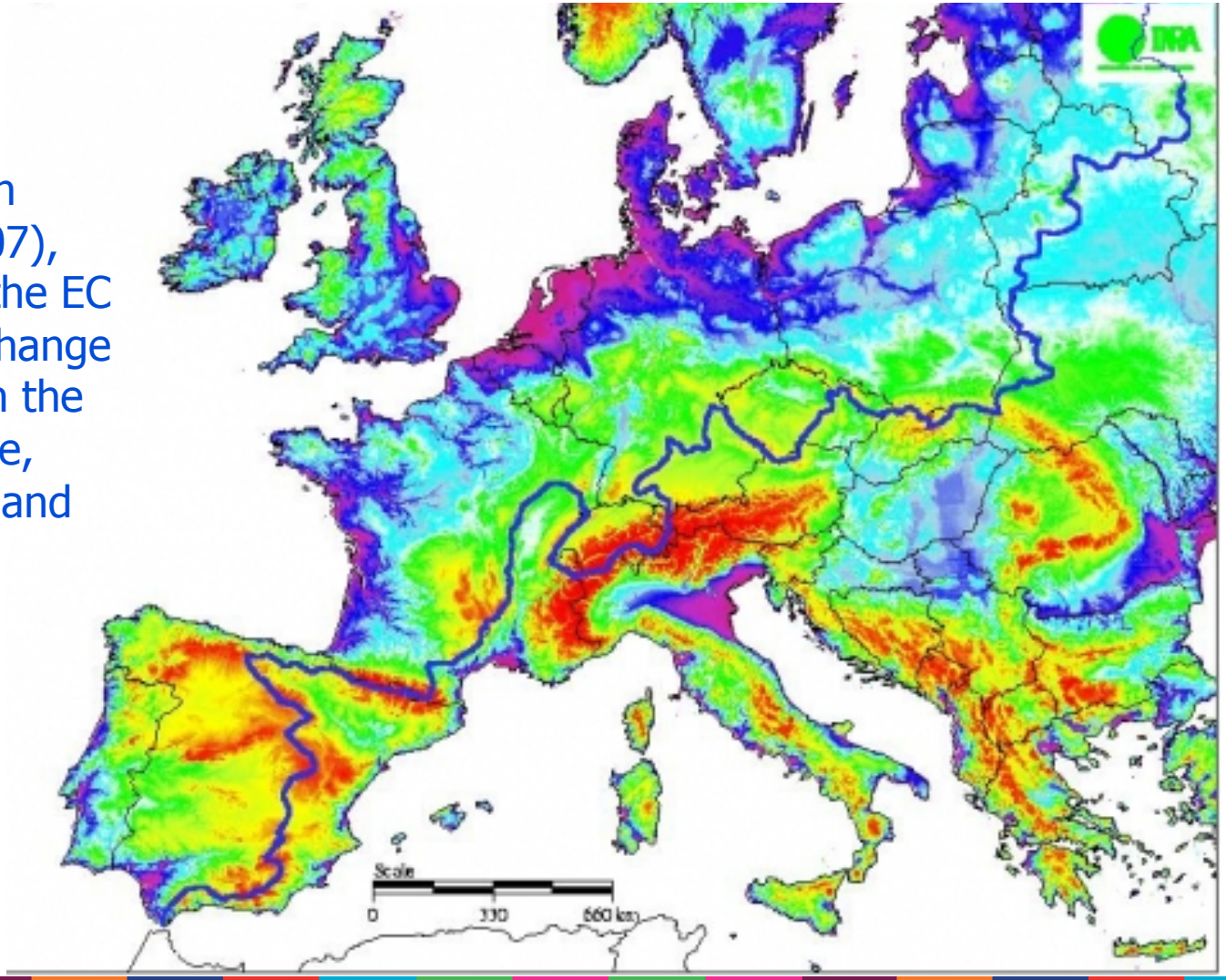
Examples of integrated problems: increasing dry conditions in the Western Mediterranean

From Millán Millán (2007), Report to the EC "Climate Change Impacts on the Water Cycle, Resources and Quality"



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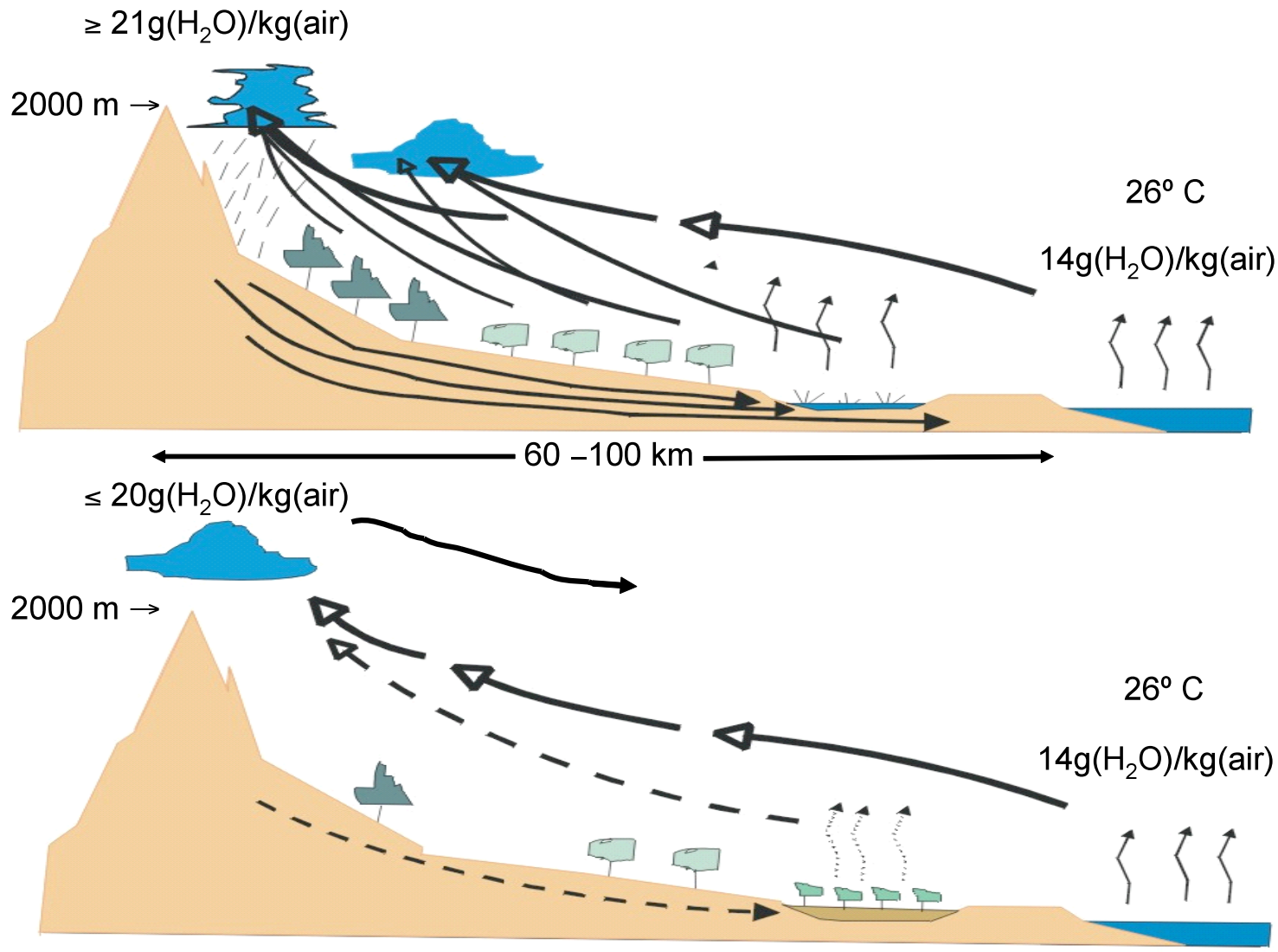
The summer storm cycle



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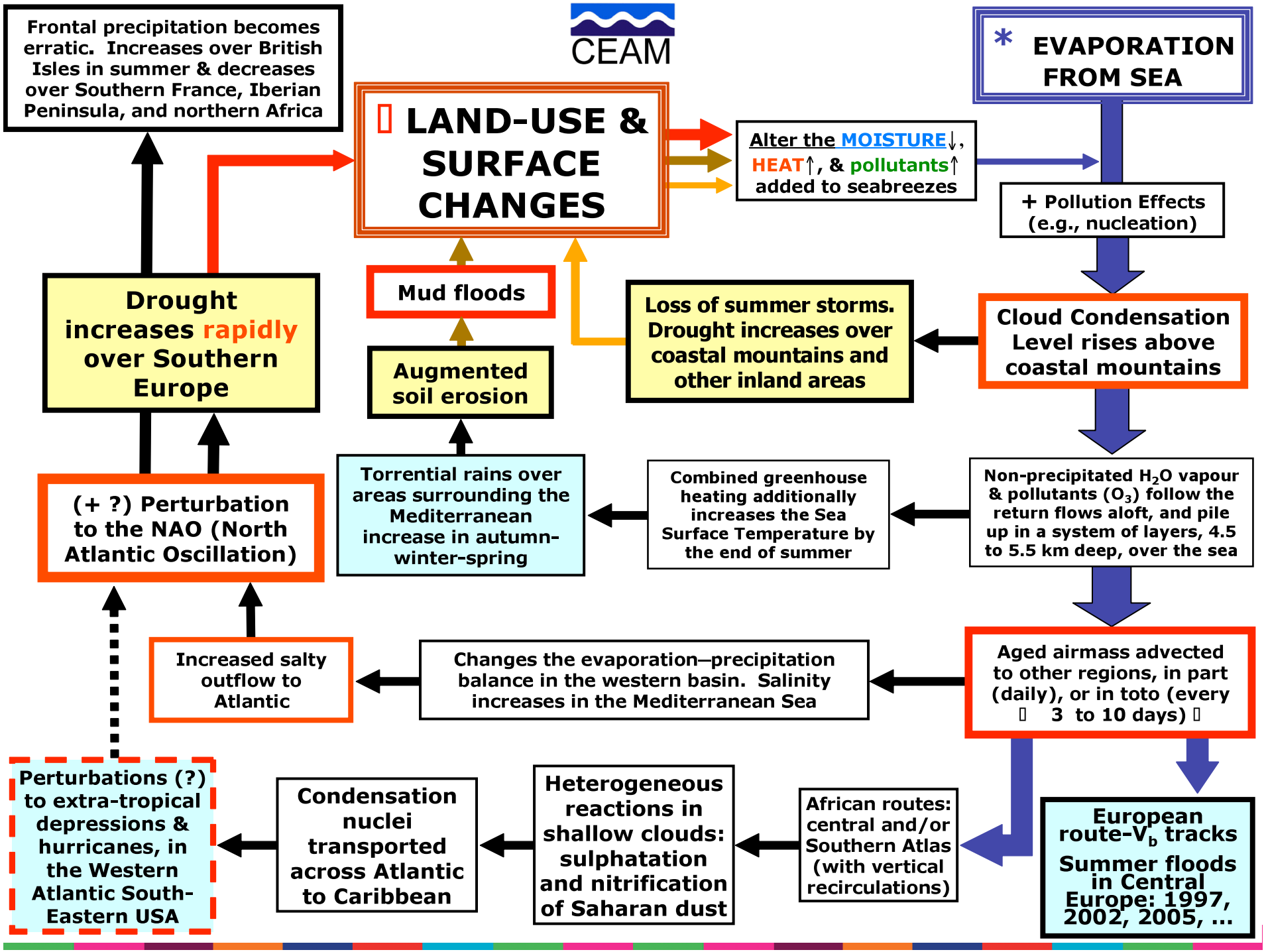
CEAM
Frontal precipitation becomes erratic. Increases over British Isles in summer & decreases over Southern France, Iberian Peninsula, and northern Africa
LAND-USE & SURFACE CHANGES
* EVAPORATION FROM SEA
Alter the MOISTURE↓, HEAT↑, & pollutants↑ added to seabreezes
+ Pollution Effects (e.g., nucleation)
Drought increases rapidly over Southern Europe
Mud floods
Augmented soil erosion
Loss of summer storms. Drought increases over coastal mountains and other inland areas
Cloud Condensation Level rises above coastal mountains
(+ ?) Perturbation to the NAO (North Atlantic Oscillation)
Torrential rains over areas surrounding the Mediterranean increase in autumn-winter-spring
Combined greenhouse heating additionally increases the Sea Surface Temperature by the end of summer
Non-precipitated H_2O vapour & pollutants (O_3) follow the return flows aloft, and pile up in a system of layers, 4.5 to 5.5 km deep, over the sea
Increased salty outflow to Atlantic
Changes the evaporation–precipitation balance in the western basin. Salinity increases in the Mediterranean Sea
Aged airmass advected to other regions, in part (daily), or in toto (every 3 to 10 days)
Perturbations (?) to extra-tropical depressions & hurricanes, in the Western Atlantic South-Eastern USA
Condensation nuclei transported across Atlantic to Caribbean
Heterogeneous reactions in shallow clouds: sulphatation and nitrification of Saharan dust
African routes: central and/or Southern Atlas (with vertical recirculations)
European route-V_b tracks
Summer floods in Central Europe: 1997, 2002, 2005, ...

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Consequences

- In the Western Mediterranean basin, over 80% of precipitated water originates from the same basin
- Vegetation (and irrigated agriculture) provides an indispensable service of water cycling
- Re-allocation of irrigation water to other uses may have the effect of reducing precipitations and increasing desertification
- Environmental externalities can be internalised only by management institutions governing the full water cycle at appropriate scale

- This example may help to think with open mind to adaptation strategies

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Not all water uses are equal

- Irrigation: through evapo-transpiration it recycles water; only bad irrigation practices lead to runoff.
  - Fertilizers → eutrophication
  - Pesticides → pollution
- Urban use → Degraded quality → Pollution → Discharge
  Degraded quality → Potential reuse
- Industrial use → Cooling → Pollution → Discharge
  Cooling → Evaporation
  → Process → Pollution → Discharge
  Pollution → Reuse
  → Water in products

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Adaptive management: the NeWater project

- NeWater: New Approaches to Adaptive Water Management under Uncertainty
  - 43 partners
  - 12 M€ of EC contribution
  - 4 years
  - Coordinator: Claudia Pahl-Wostl, University of Osnabrueck (DE)

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NeWater: key findings

- Adaptive management to cope with uncertainty and complexity
- Key components:
  - Social Learning
  - Scenario Planning
- A broaden role for models: importance of integrated modelling
- Need to cope with (inevitable) uncertainty due to climate change and other factors – which is today the main barrier to adaptation

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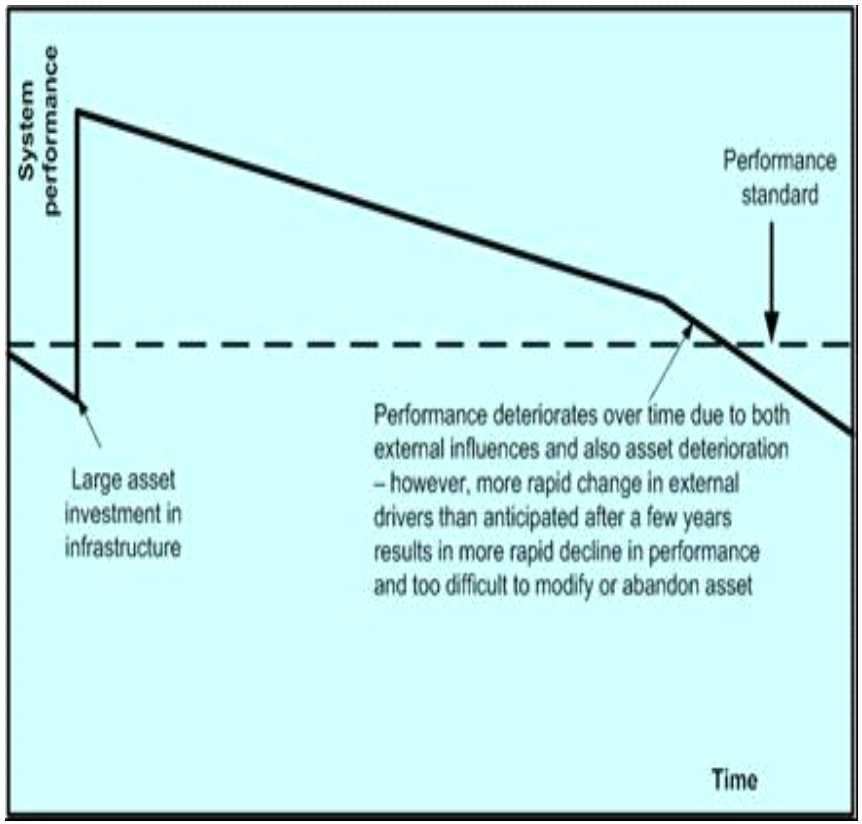
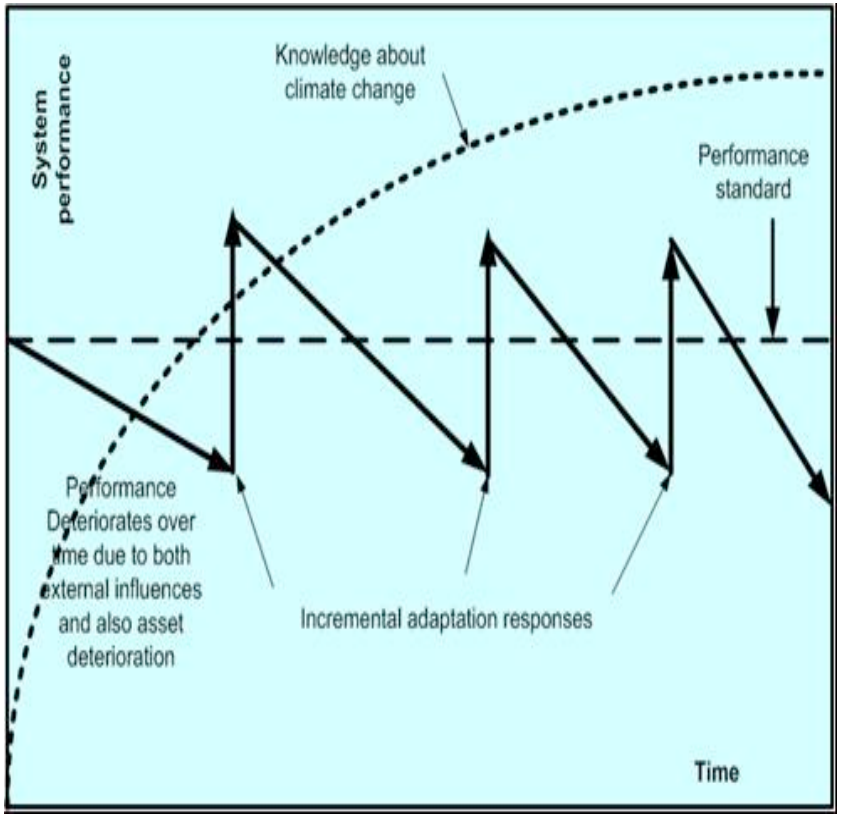
Adaptive management





(From PREPARED)

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Integrated modelling

- The EC-funded HarmonIT project developed OpenMI®, a software environment that allows different models – when "OpenMI compliant" – to exchange data and effectively work together
- Today, most commercial hydrological software is OpenMI compliant, and it is possible to combine e.g. a runoff model, with a river quality model, with a groundwater flow model, obtaining integrated results

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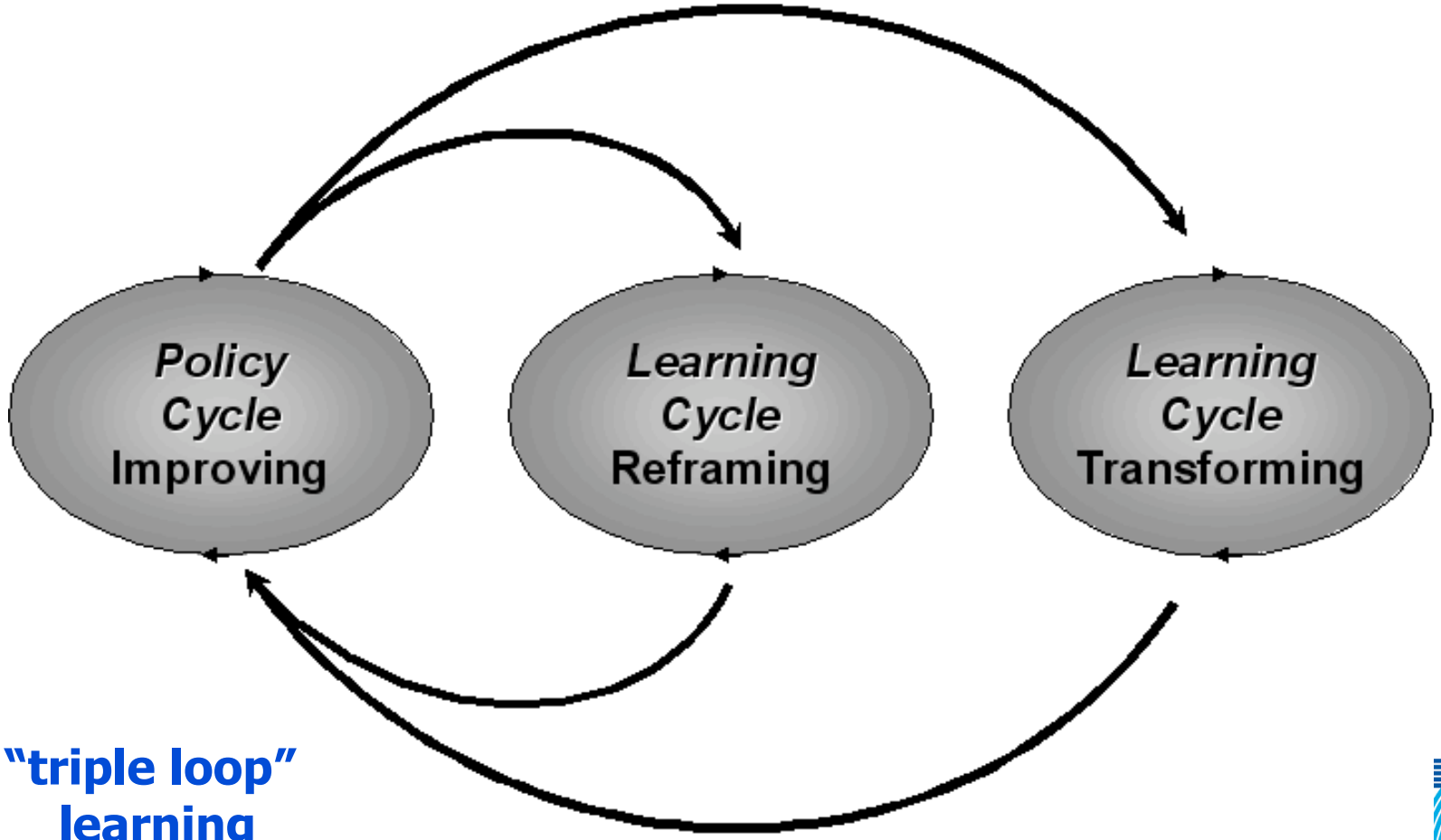
NeWater: how to manage change



"triple loop" learning

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Adaptation of water supply and sanitation systems to cope with Climate Change: the PREPARED project

- PREPARED: "Enabling Change"
  - 35 partners
  - 7 M€ of EC contribution
  - 4 years from September 2009
  - Coordinator: Adriana Hulsmann, KWR Water b.v. (NL)

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PREPARED: key elements

- The project PREPARED aims to gather urban utilities in Europe and worldwide that (will) have an advanced strategy in meeting the upcoming challenges for water supply and sanitation brought about by climate change.
- Adaptation: 1) building adaptation capacity; 2) delivering adaptation actions (short- and long-run)
- Building resilience
- Water specificity: quantity AND quality
- Water Cycle Safety Plans

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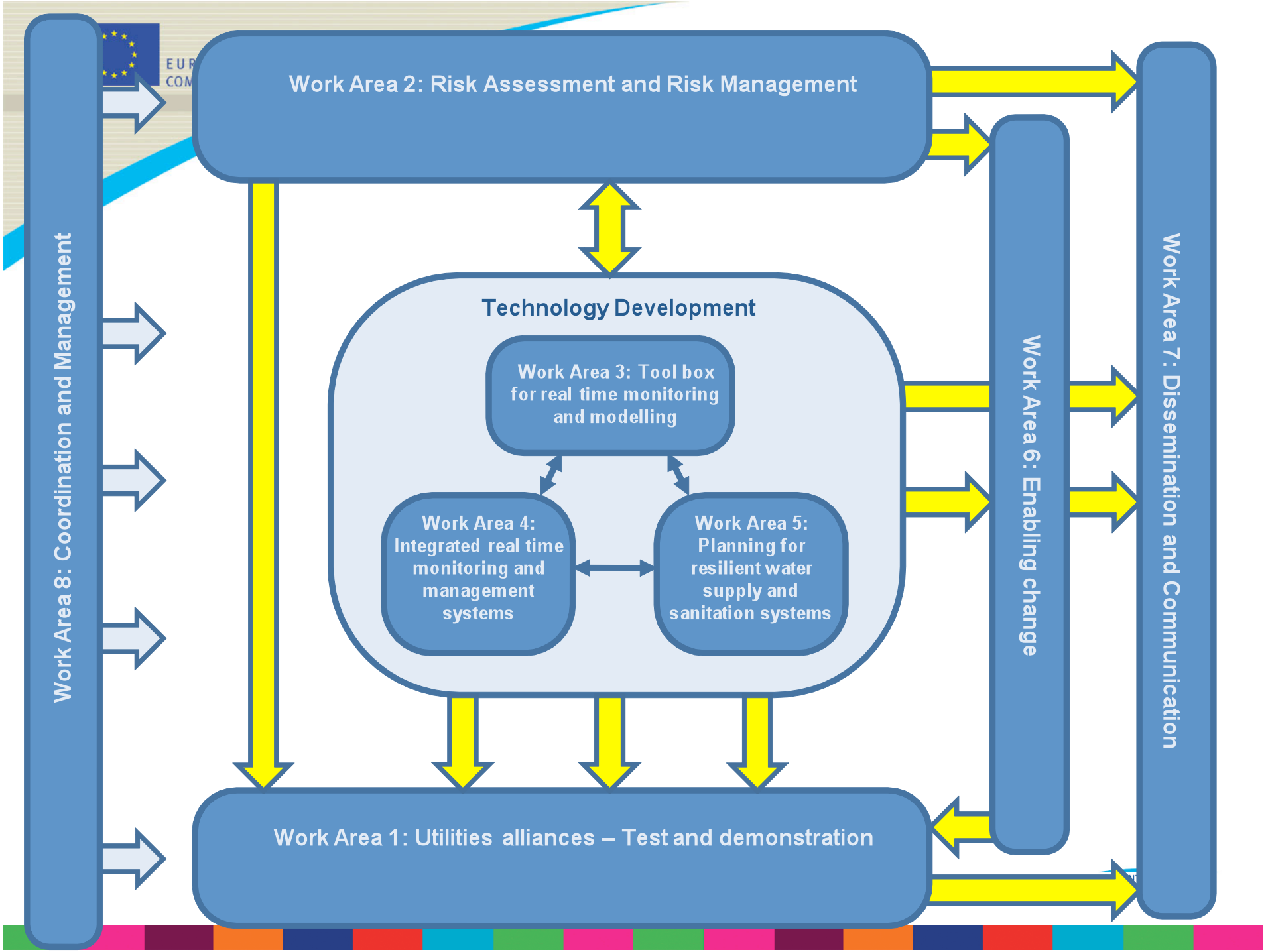
Work Area 2: Risk Assessment and Risk Management
Work Area 8: Coordination and Management
Technology Development
Work Area 3: Tool box for real time monitoring and modelling
Work Area 4: Integrated real time monitoring and management systems
Work Area 5: Planning for resilient water supply and sanitation systems
Work Area 6: Enabling change
Work Area 7: Dissemination and Communication
Work Area 1: Utilities alliances – Test and demonstration

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Conclusions - 1

- The hydrological cycle is impacted AND impacts on climate change at different scales
- Complex feedback mechanisms and other factors increase the uncertainty framework
- Climate models are not usable for hydrologic purposes; their downscaling have to be coupled with the upscaling of local processes in order to generate usable models
- Increase the knowledge base through data sharing and integrated modelling capacity

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Conclusions - 2

- Adaptive management: build consensus through social learning to take knowledge-based decisions
- Only water cycle managing institutions, at the proper scale, may be capable of internalising the externalities, of solving the conflicts among competing uses and of efficiently allocating water resources in a rapidly changing context
- Data sharing - Hydrological observatories

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Thanks for your attention!

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