Disruption risk analysis in the Mediterranean

gaps and challenges highlighted by Storm Daniel

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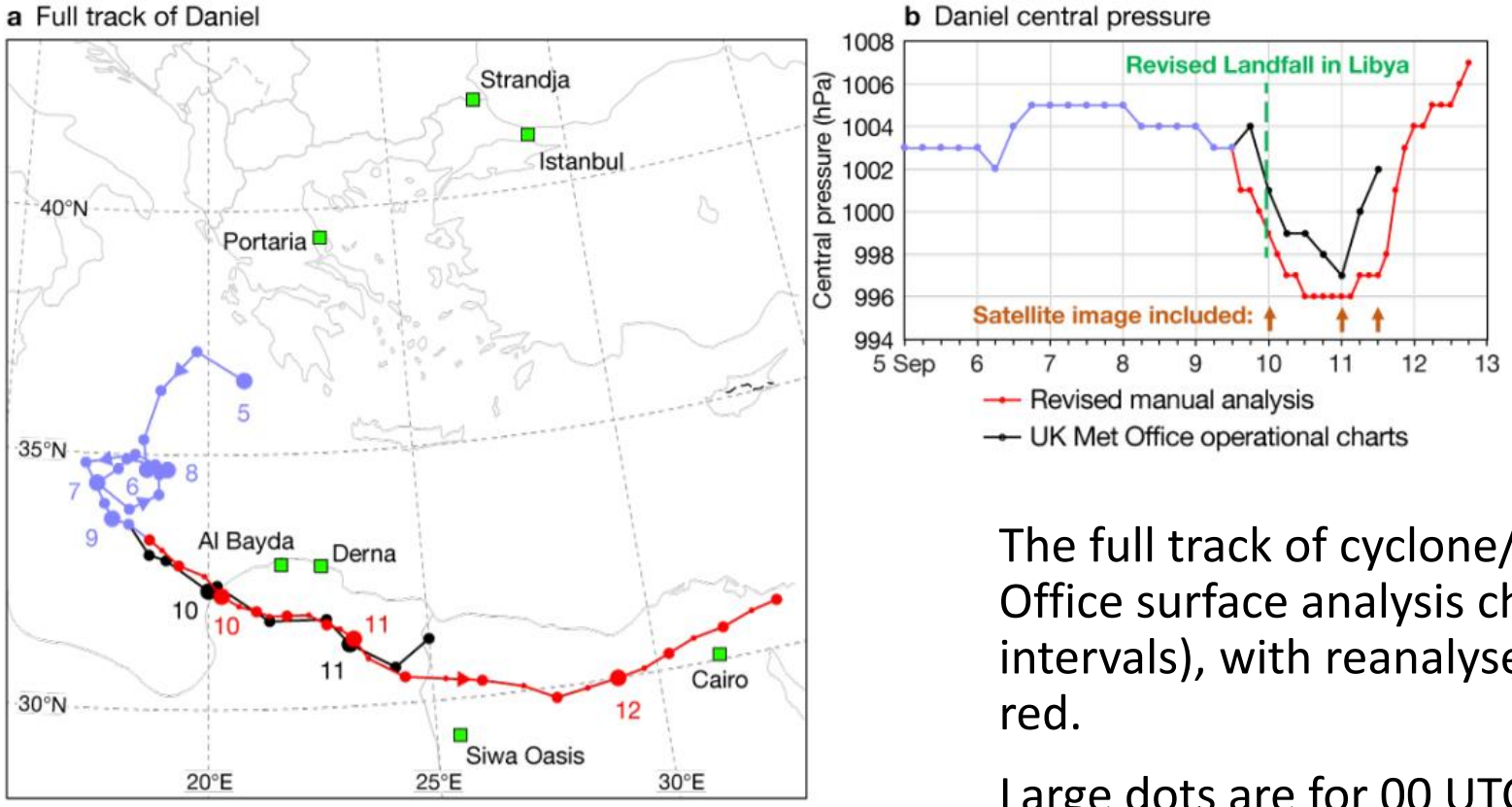
Cofinanciado por:

Daniel: an extraordinary cyclone with devastating impacts



Hewson *et al.* 2024 (ECMWF)

The full track of cyclone/medicane Daniel from Met Office surface analysis charts (blue and black at 6 h intervals), with reanalysed positions at 3 h intervals in red.

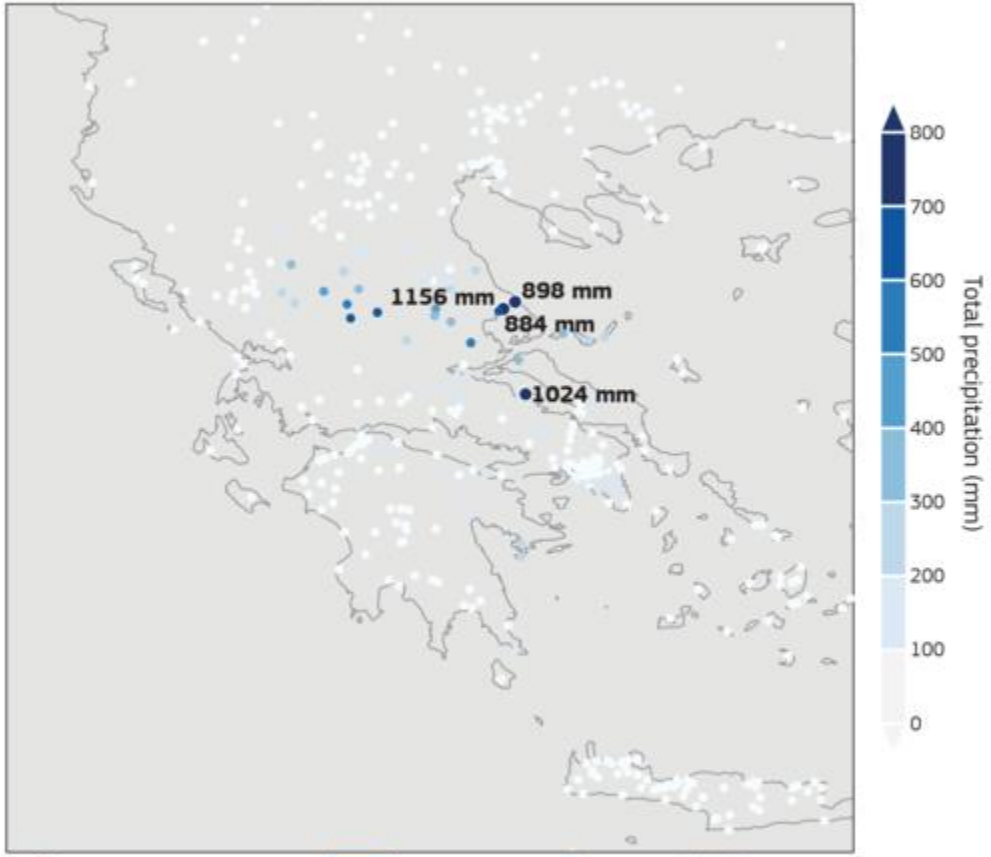
Large dots are for 00 UTC, medium for 06, 12, 18 UTC, small for 03, 09, 15, 21 UTC. Numbers denote the date (September 2023) for 00 UTC positions.

Daniel: record-breaking rainfall to Greece

some locations receiving the equivalent of an average year's worth of rain in less than a day

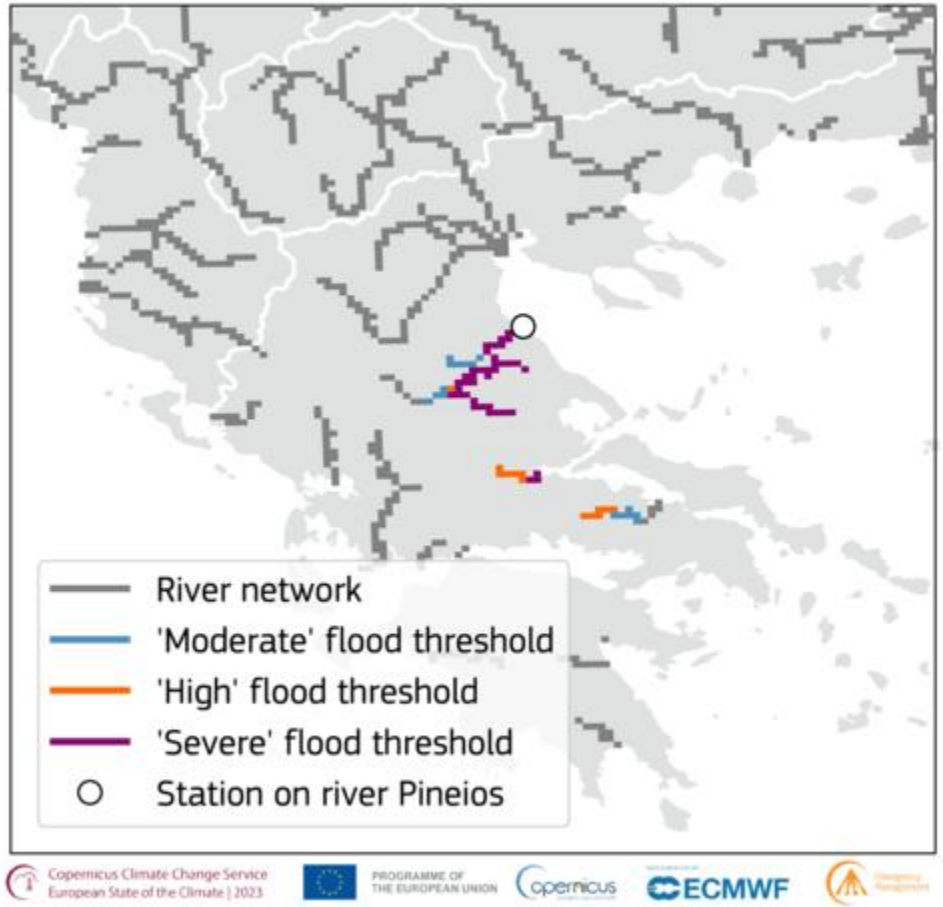
Total precipitation associated with Storm Daniel, 4–6 September 2023

Data: SYNOP/National Observatory of Athens • Credit: C3S/ECMWF

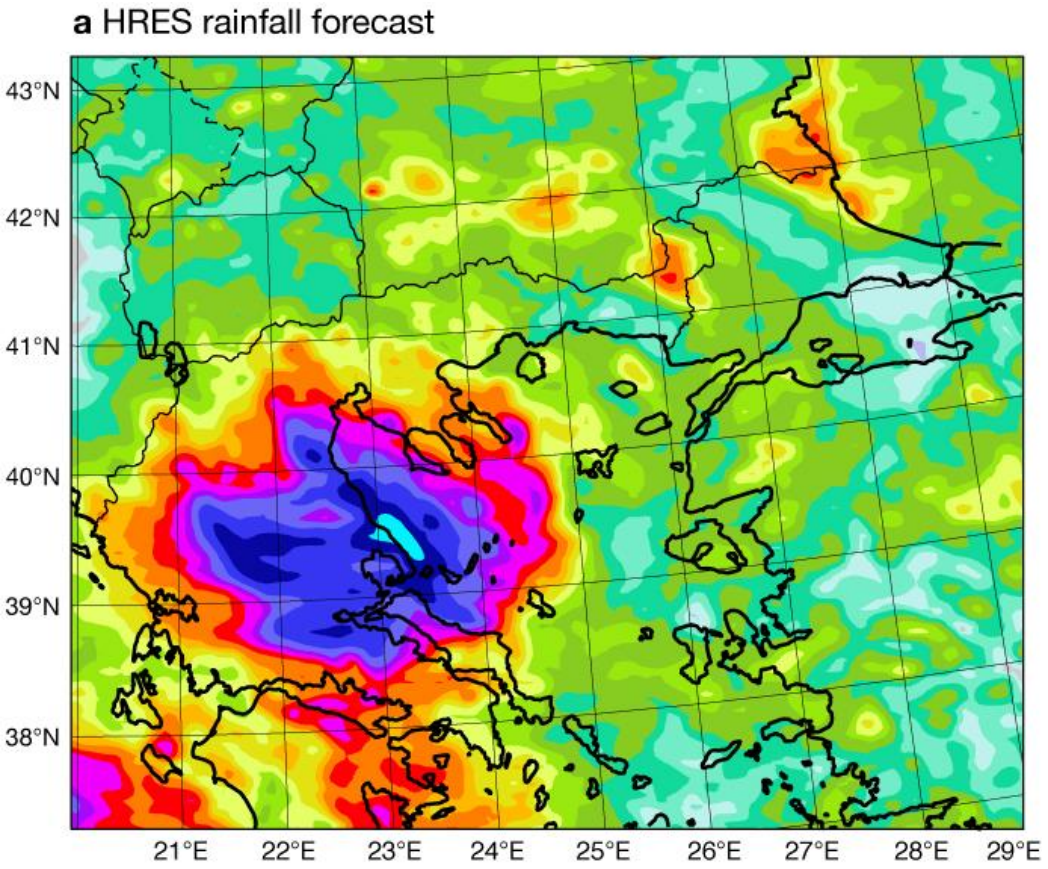


Peak river flow reached during Storm Daniel, 5 September 2023

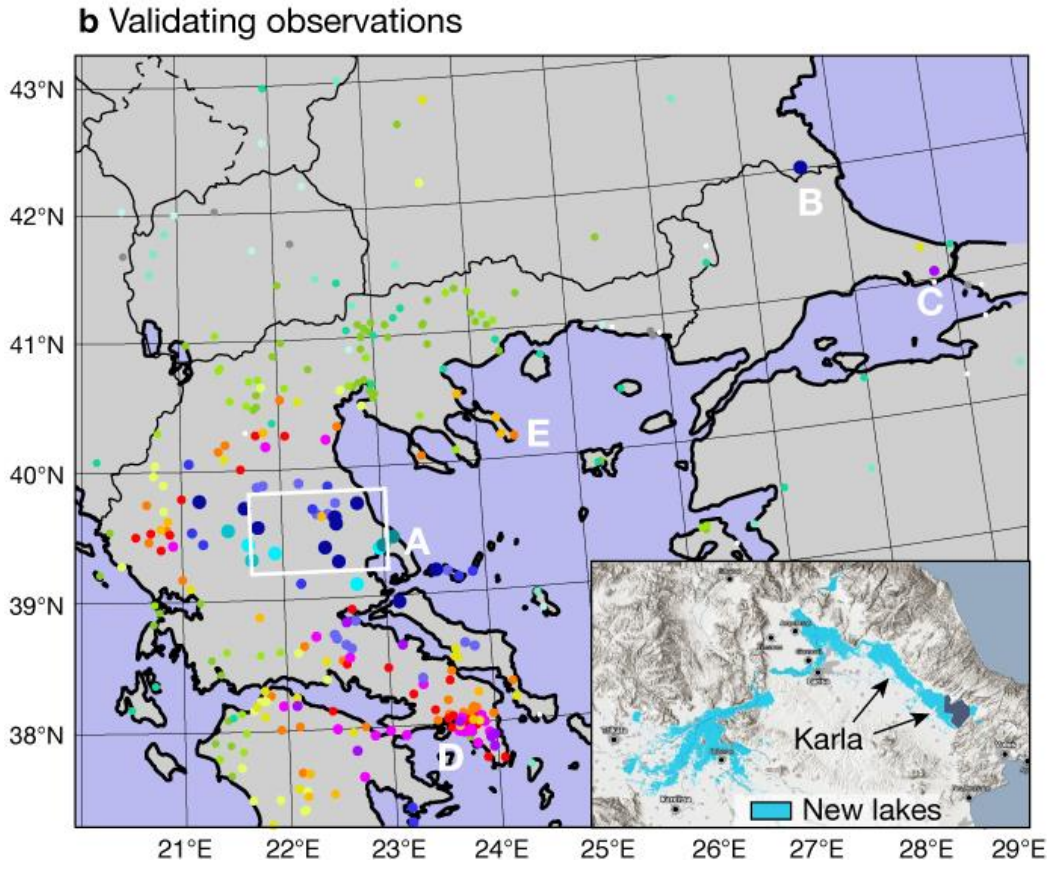
Data: EFAS • Credit: CEMS/C3S/ECMWF



Daniel: record-breaking rainfall to Greece



4-day rainfall from HRES (9 km resolution)

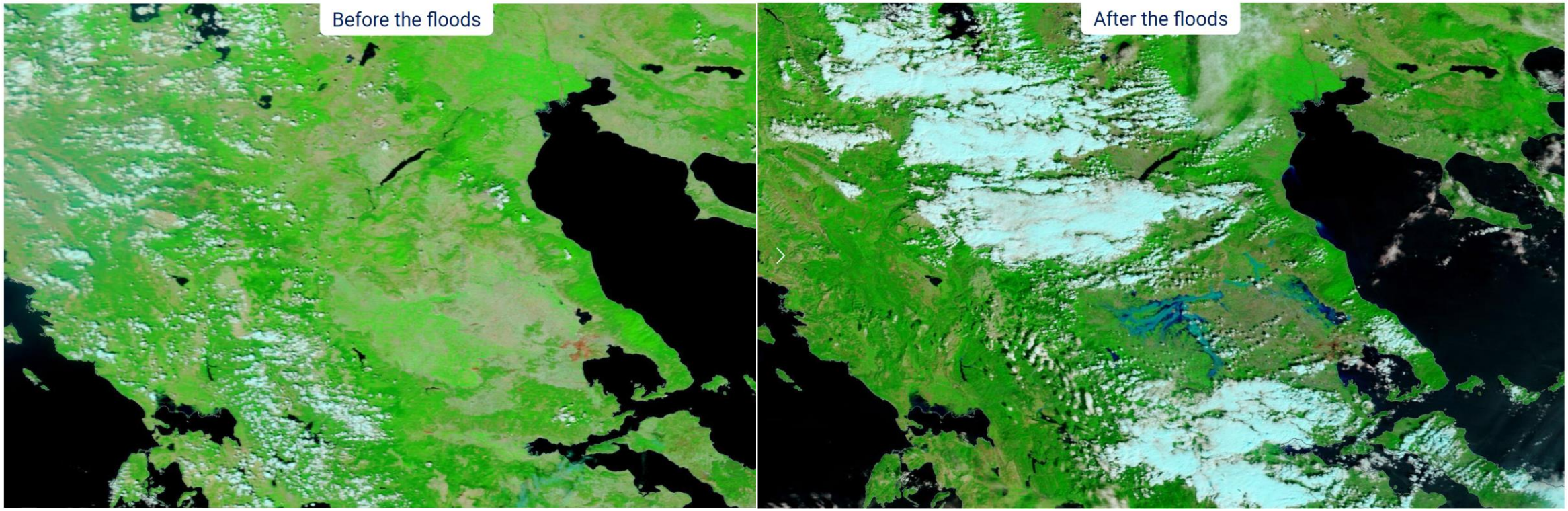


validating observations, with quality control and manual gap filling applied for gauges in the Thessaly region in central Greece, where a few data outages occurred. The inset box shows where new lakes formed due to the extreme rainfall.

Hewson *et al.* 2024 (ECMWF)

Daniel: record-breaking rainfall to Greece

After the rain event ended over Greece on 8 September, the skies cleared revealing the devastating aftermath, especially the flooded plain of Thessaly



Terra MODIS custom RGB (R:2.25um, G:0.8um, B:0.6um), left, 31 August 2023, right, 8 September 2023

EUMETSAT user portal
https://user.eumetsat.int/resources/case-studies/extreme-floods-in-libya-and-central-greece

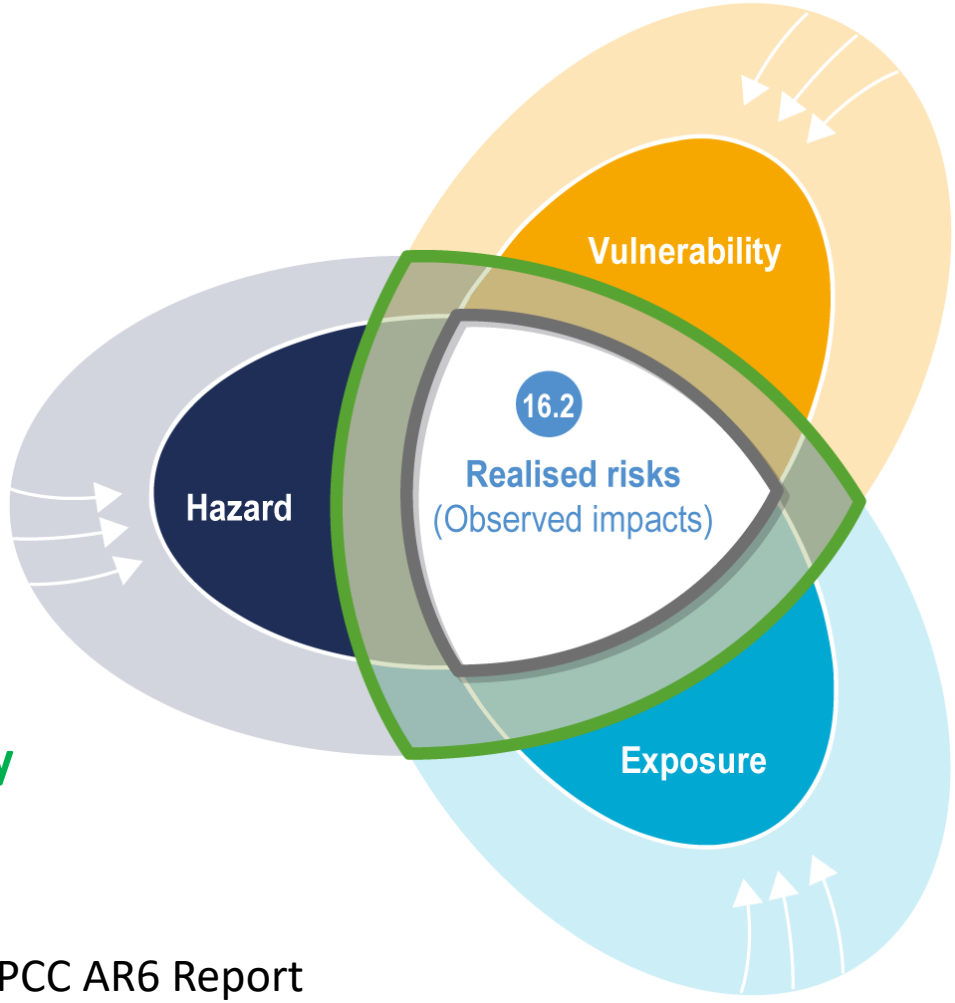
Conceptual framework of risk used in IPCC

Climate-related hazards (e.g. cyclones, heatwaves, prolonged droughts and floods)

and multi-hazard

Probability

Susceptibility



Economic value

Adapted from Figure 16.1 IPCC AR6 Report Impacts, Adaptation and Vulnerability

Observed impacts

Storm Daniel hit Greece for three days, leaving a trail of ruin after a record summer heatwave that had touched off huge wildfires.

Homes were swept away by torrents, bridges collapsed, roads were made impassable, power lines fell and crops in the fertile Thessaly plain were wiped out.


ΠΛΙΝΘΟΚΕΡΑΜΟΠΟΙΕΙΑ Ν.Σ. ΤΣΑΛΑΠΑΤΑ

Observed impacts
MedCyclone Report (Daniel_v1)

Human Impacts:

- Storm Daniel caused at least 11,325 fatalities and about 4,000 people have been injured (until 15 September 2023).
- Evacuation orders were issued, leading to the displacement of 9,047 residents in Central Greece.
- Significant power outages affected millions of people.
- Remaining swamp muddy areas pose concerns for water quality and other health related conditions.

Infrastructure and Property Damage:

- Widespread structural damage to homes, businesses, and public buildings. About 50 buildings have collapsed in Greece and more than 1,000 in Libya.
- Flooding damaged roads, bridges, and other critical infrastructure.
- Coastal communities experienced erosion and marine submersion.

Observed impacts
MedCyclone Report (Daniel_v1)

Agricultural and livestock Impact:

- Crop damage, particularly to cotton, corn, and apples, was extensive.
- The storm disrupted fishing and aquaculture operations.
- More than 200,000 animals in Greece used as livestock, have been declared dead.

Economic Impact:

Estimated economic losses from Storm Daniel exceeded $4 billion, including insured and uninsured losses.

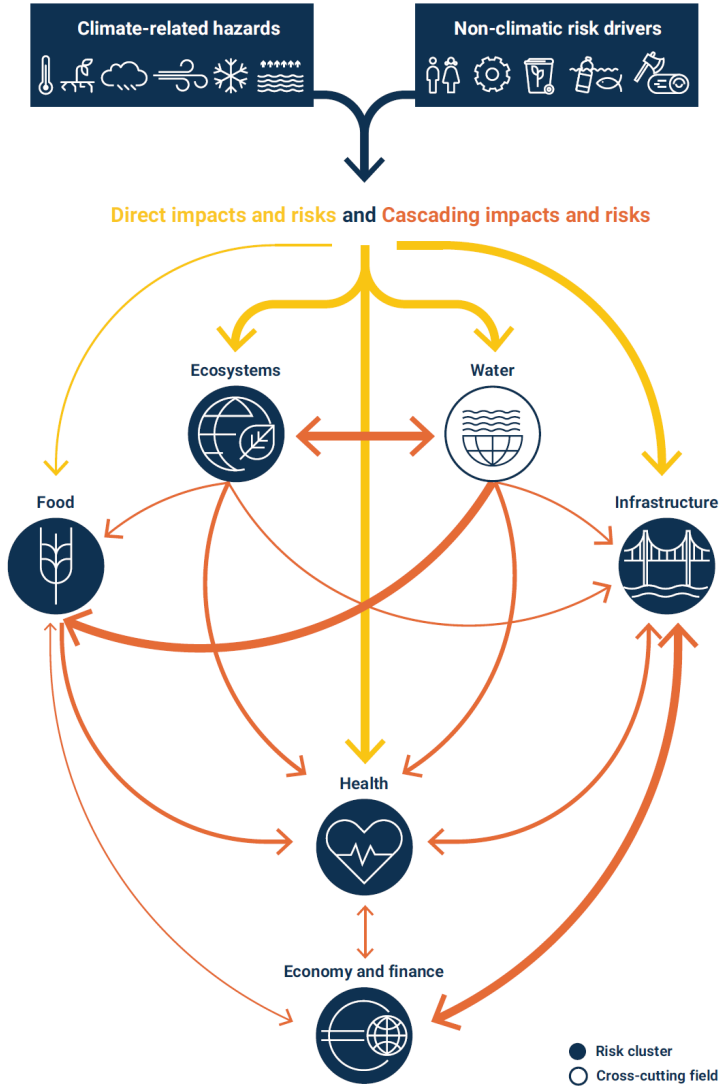
Observed impacts were severe and prolonged for several months

Dafis *et al.* 2023

Risk cascades

European Environment Agency (2024) identifies **5 clusters** and stresses that **a risk** originating in one system **is transmitted to** others. Examples of risk cascades include:

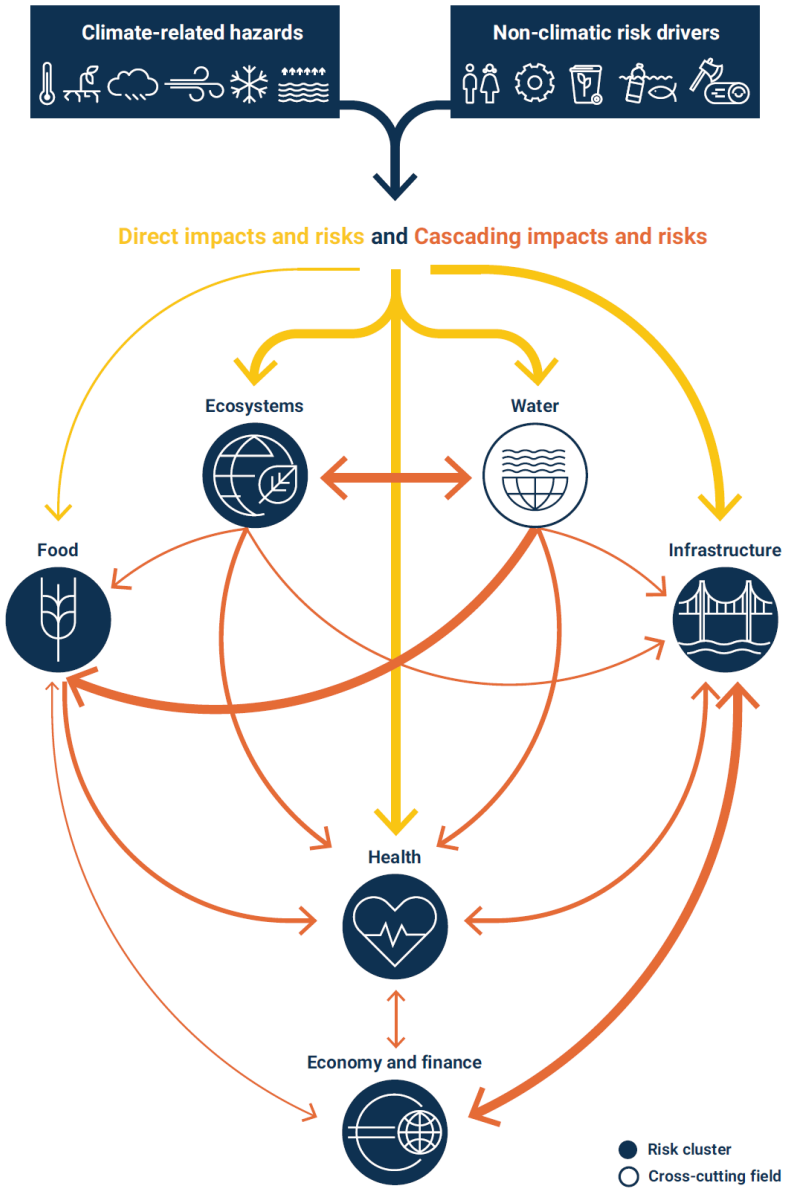
- **Food.** Climate impacts on **food production** (particularly in southern Europe) can cascade to rural and coastal livelihoods, land use, the health of socially vulnerable populations, and the wider economy.
- **Health.** Climate impacts on **human health and well-being**, including those of workers, can affect labour productivity and resource needs of the health system, and thus the wider economy.
- **Ecosystems.** Climate impacts on **terrestrial, freshwater and marine** ecosystems can cascade to food production and security, human and animal health, infrastructure, land use and the wider economy.
- **Infrastructure.** Climate impacts on **critical infrastructure**, such as energy, water or transport infrastructure, can affect nearly all aspects of society, from human health to the wider economy and the financial system. Infrastructure assets and networks are often interconnected, so a failure at one point in the network can also cascade to other regions and countries.
- **Economy and finance.** Many climate impacts can affect the economy and the financial system, from where they can cascade further to other policy areas that may be deprived of financial resources.



(European Climate Risk Assessment, 2024)

Links between risk drivers and the clusters of climate risks assessed

Interconnections and risk transmission **pathways** from key climate-related hazards and selected non-climatic risk drivers (on top) via the main climate impacts for five clusters of interrelated risks and the **cross-cutting field 'Water'**.



(European Climate Risk Assessment, 2024)

Awareness of risk cascades is crucial for reducing climate risks because it offers different possible targets for risk reduction strategies.

It is often more efficient to address a risk at the beginning of the cascade than where the impacts are felt most strongly.

Comprehensive adaptation policies need to prevent the deterioration of the foundation of basic human needs (such as ecosystems, food and health) while promoting the resilience of human systems and activities (such as infrastructure, economy and finance).

(European Climate Risk Assessment, 2024)

The challenge for the Scientific Community

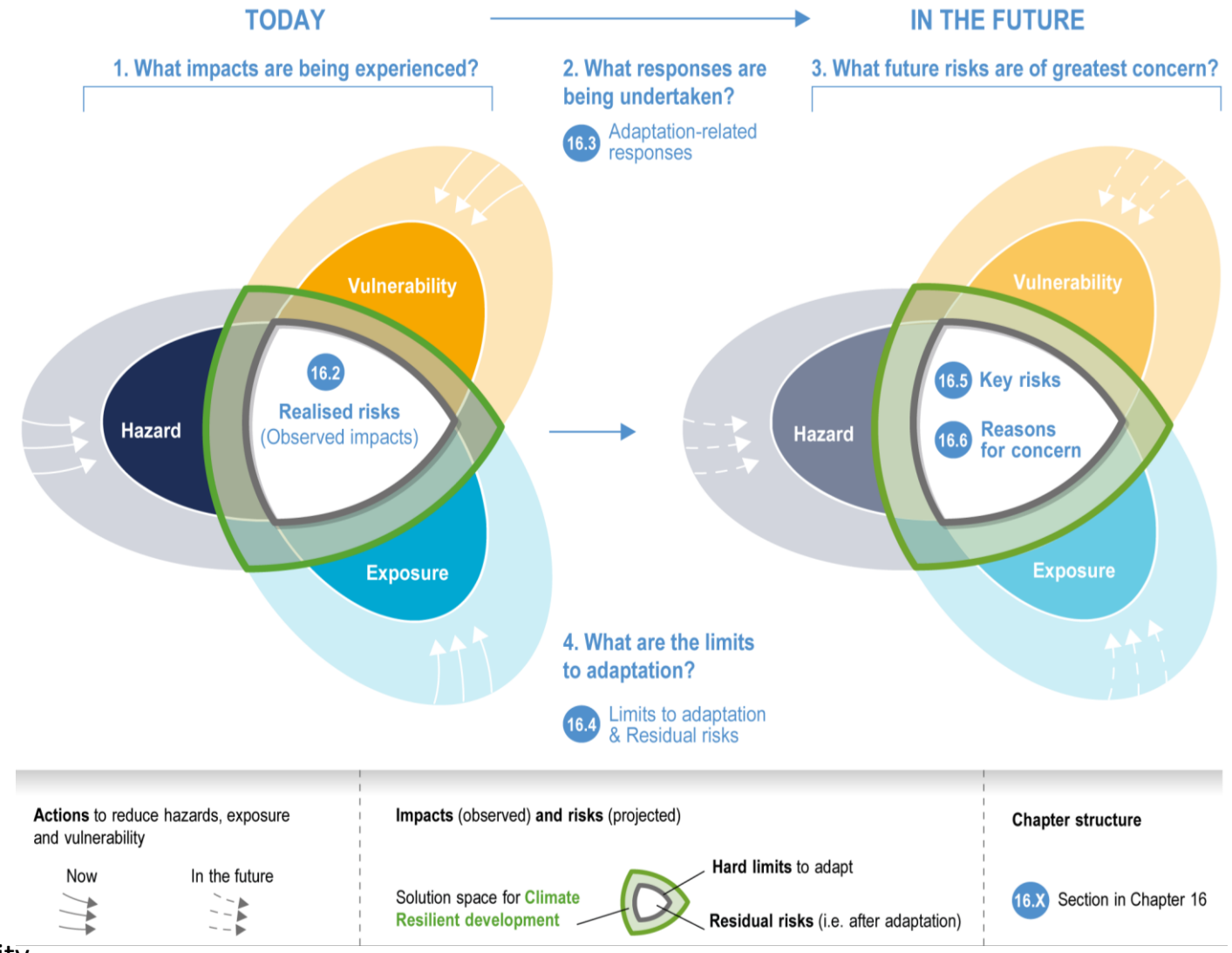


Figure 16.1 IPCC AR6 Report
Impacts, Adaptation and Vulnerability

Gaps and challenges highlighted by Storm Daniel

Storm Daniel highlights the need to:

- continue improving ability **to predict** extreme events
- consider compound events: different hazards may occur individually, simultaneously, or in cascade - **multi-hazard assessment**
- foster **multidisciplinary** work and **awareness** building – stakeholders
- Improve **communication** and **transfer of knowledge** to society – providing information from hazard detection to timely action