# Climate Change Vulnerability in the Black Sea Catchment

Roger Bär and Anthony Lehmann

1. Introduction
2. Theory
3. Methodology
4. Results
5. Discussion
6. Conclusion

# The EU enviroGRIDS project: April 2009- March 2013

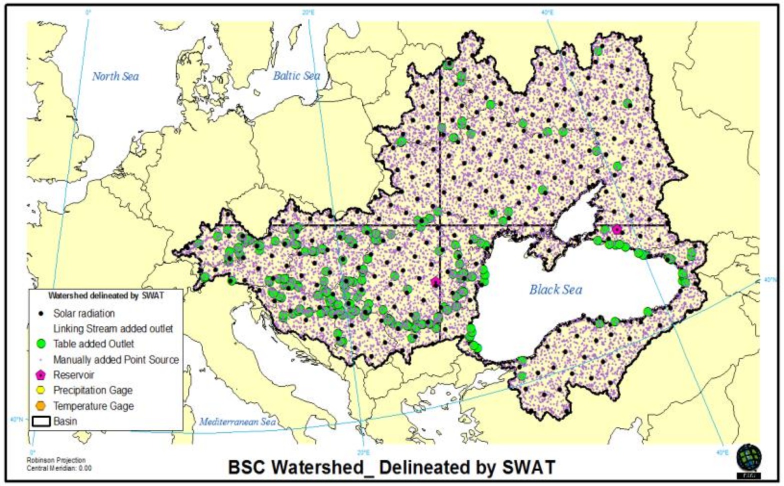
- Black Sea catchment (2.2mio $Km^2$, >150mio inhabitants)
- Data sharing through GEOSS and INSPIRE
- Nutrients loads in the Black Sea ?
- Global change impacts on water resources (climate, land cover, population) ?

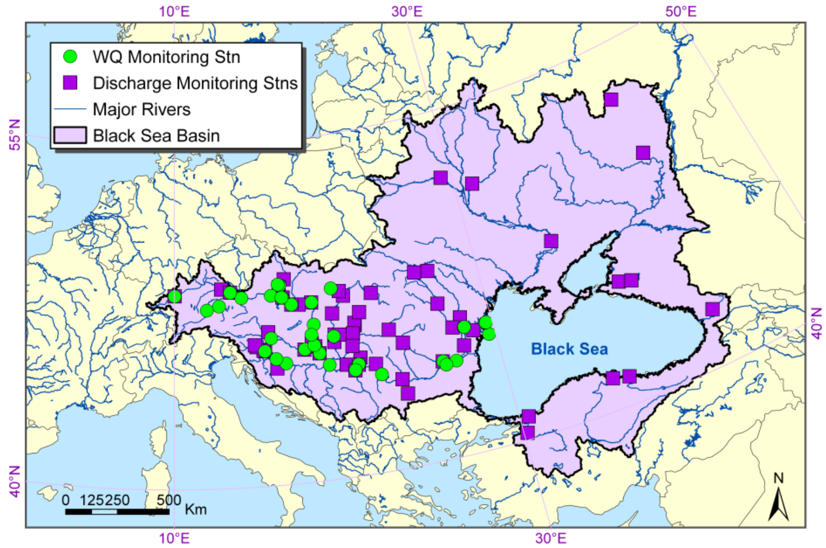

Source:

UNEP/DEWA/GRID-Europe

from Elham Rouholahnejad et al.
**Water resources quantity and quality in Black Sea Basin**
SESSION K3: LARGE SCALE APPLICATIONS

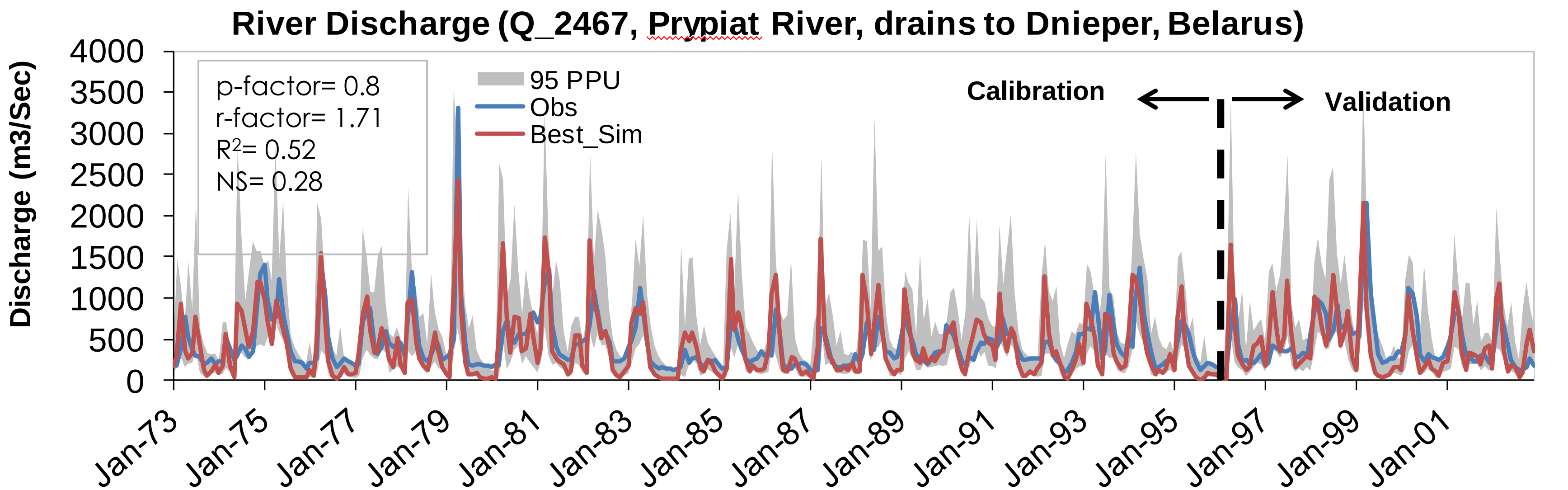
- Arc SWAT 2009
- 12982 subbasins
- 89202 Hrus
- CRU data sets as weather data
- Modis land cover
- Agricultural management for Wheat, Maize and Barely
- ET calculation based on Hargreaves Method
- Daily step SWAT run and monthly output printing was selected
- 37 yrs of simulation, 3 yrs warm up period(1970-2006)
- Each run 42 hours on a super power machine

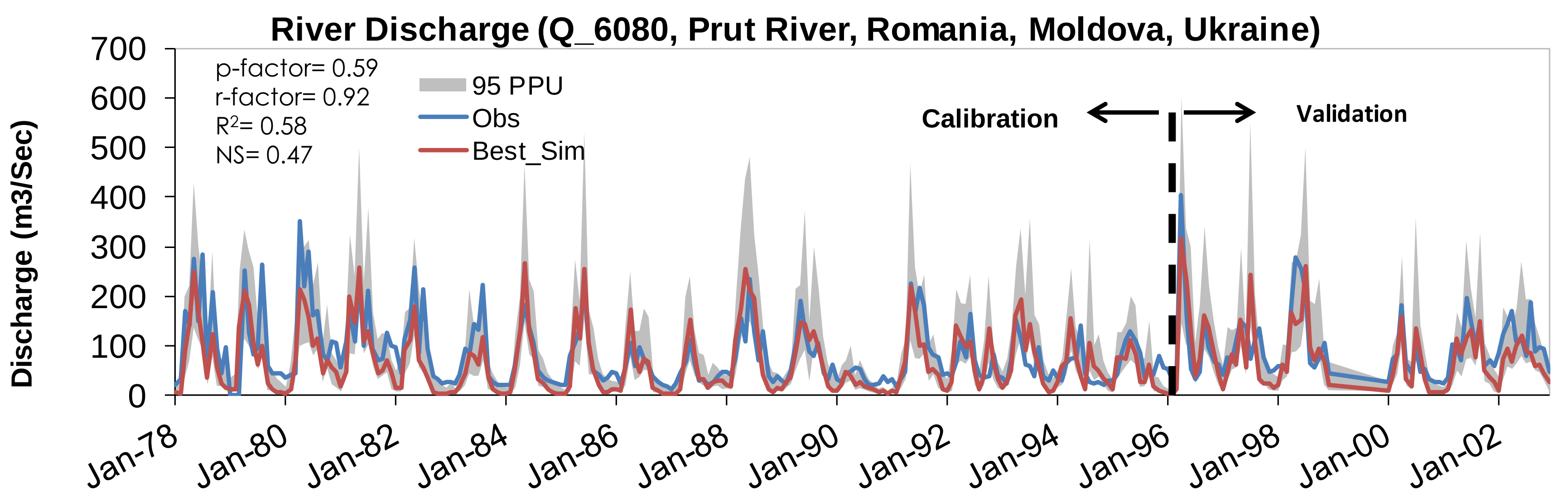


# River Discharge results

from Elham Rouholahnejad et al.
**Water resources quantity and quality in Black Sea Basin**
SESSION K3: LARGE SCALE APPLICATIONS



# Vulnerability Assessment of Agricultural Water Resources

**Vulnerability = Potential to get harmed**

## Objectives

- Assess over all vulnerability for Agriculture
- Identify vulnerable regions
- Decompose results
- Offer a country comparison

# Assessing Vulnerability

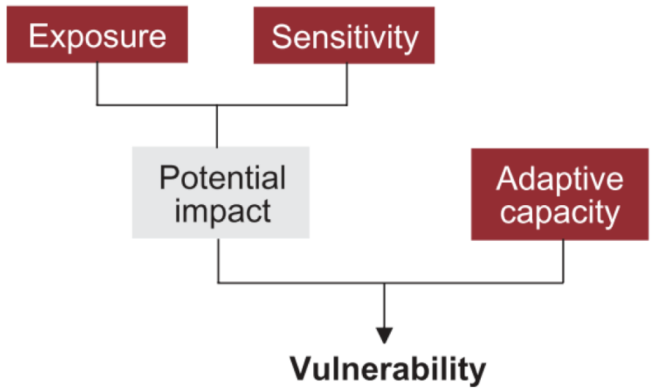
**“How can vulnerability be measured?
Strictly speaking it cannot, because vulnerability does not denote an observable phenomenon […]“.**

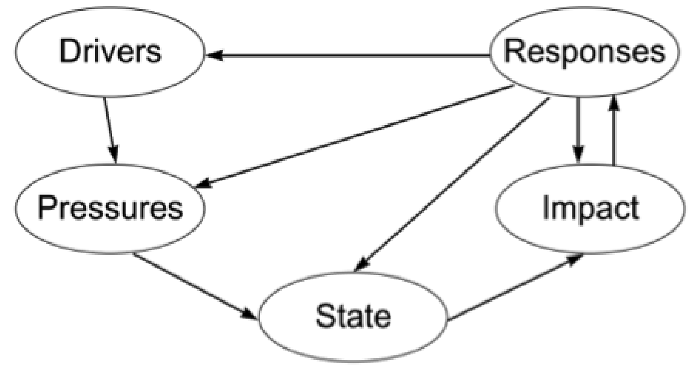
Need to make the concept operational

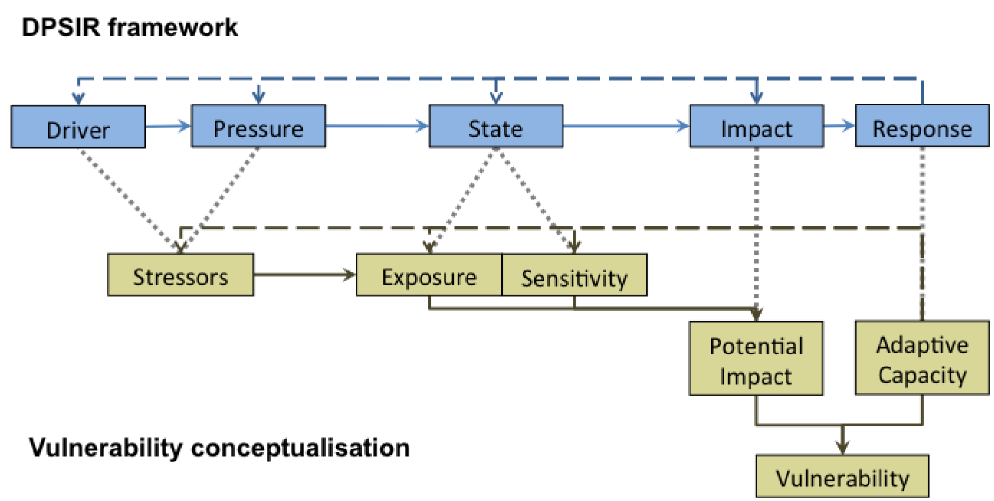
Source:

Hinkel, 2011

# Conceptualising Vulnerability



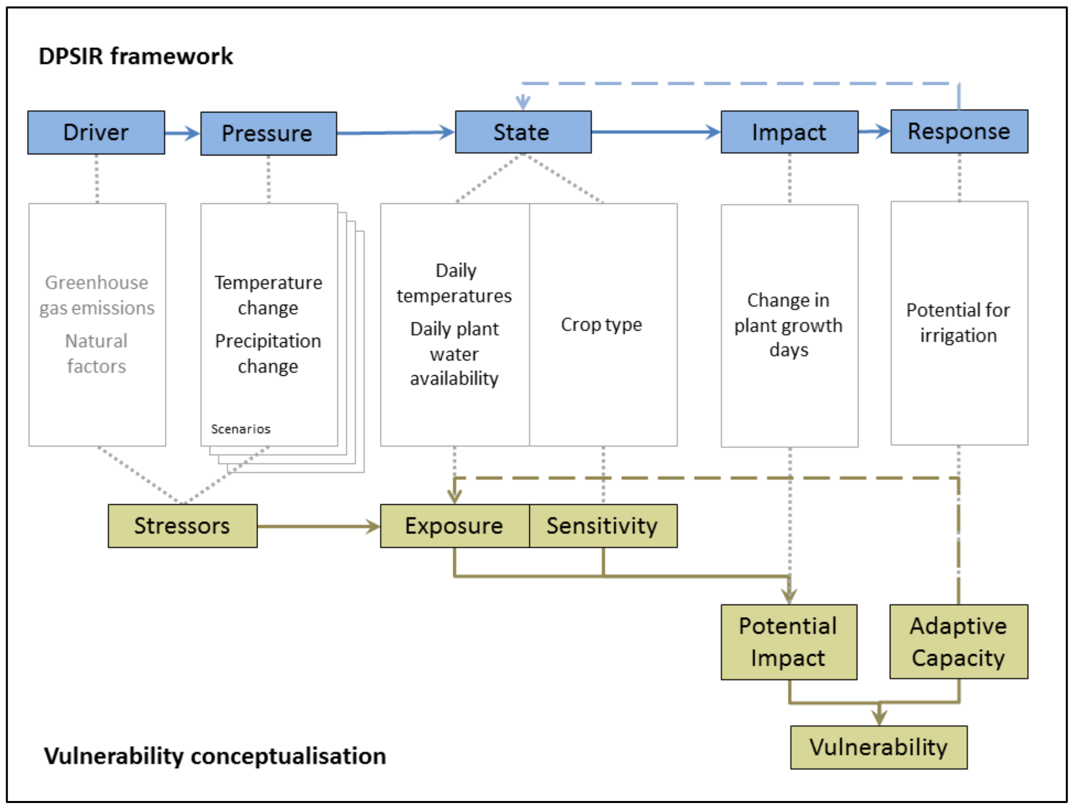

Source:

Upper left: Allen Consulting Group 2005

Upper right: Smeets & Weterings 1999

# Contextualisation for the Black Sea project

| | No Change in Temperature | 3°C Increase in Temperature |
|---|---|---|
| **No Change in Precipitation** | Recorded Data (RD) | Temperature Change (TC) |
| **30% Decrease in Precipitation** | Precipitation Change (PC) | Combined Change (CC) |



# Operationalization

**Discrepancy between the theoretical framework and the actual analysis method**

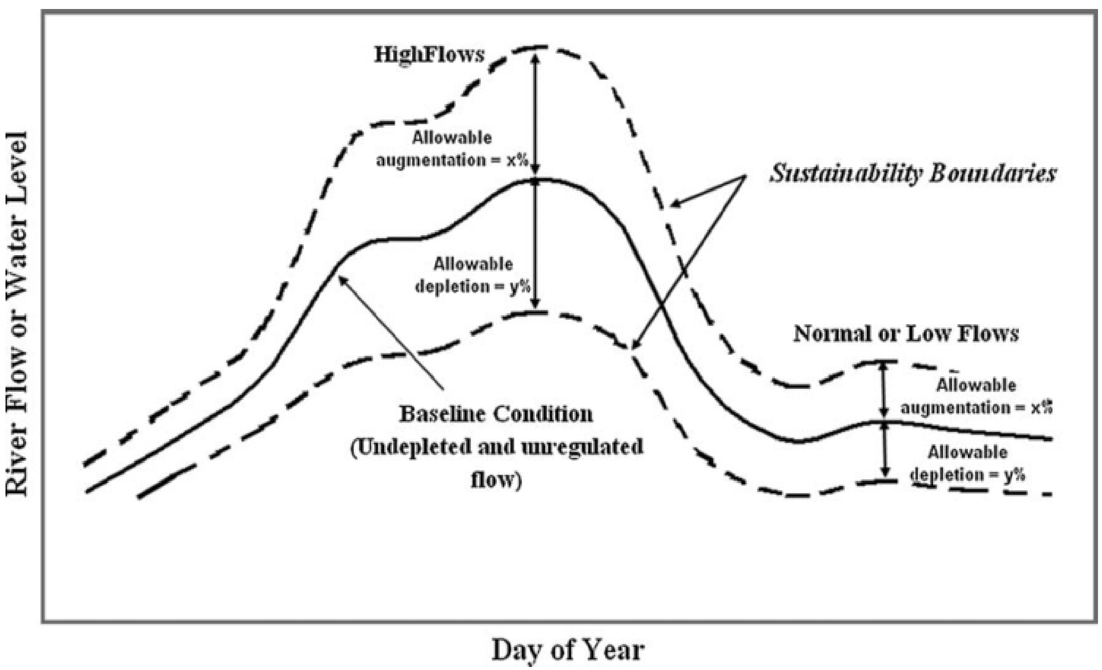
Embed vulnerability framework in SWAT

# Indicators

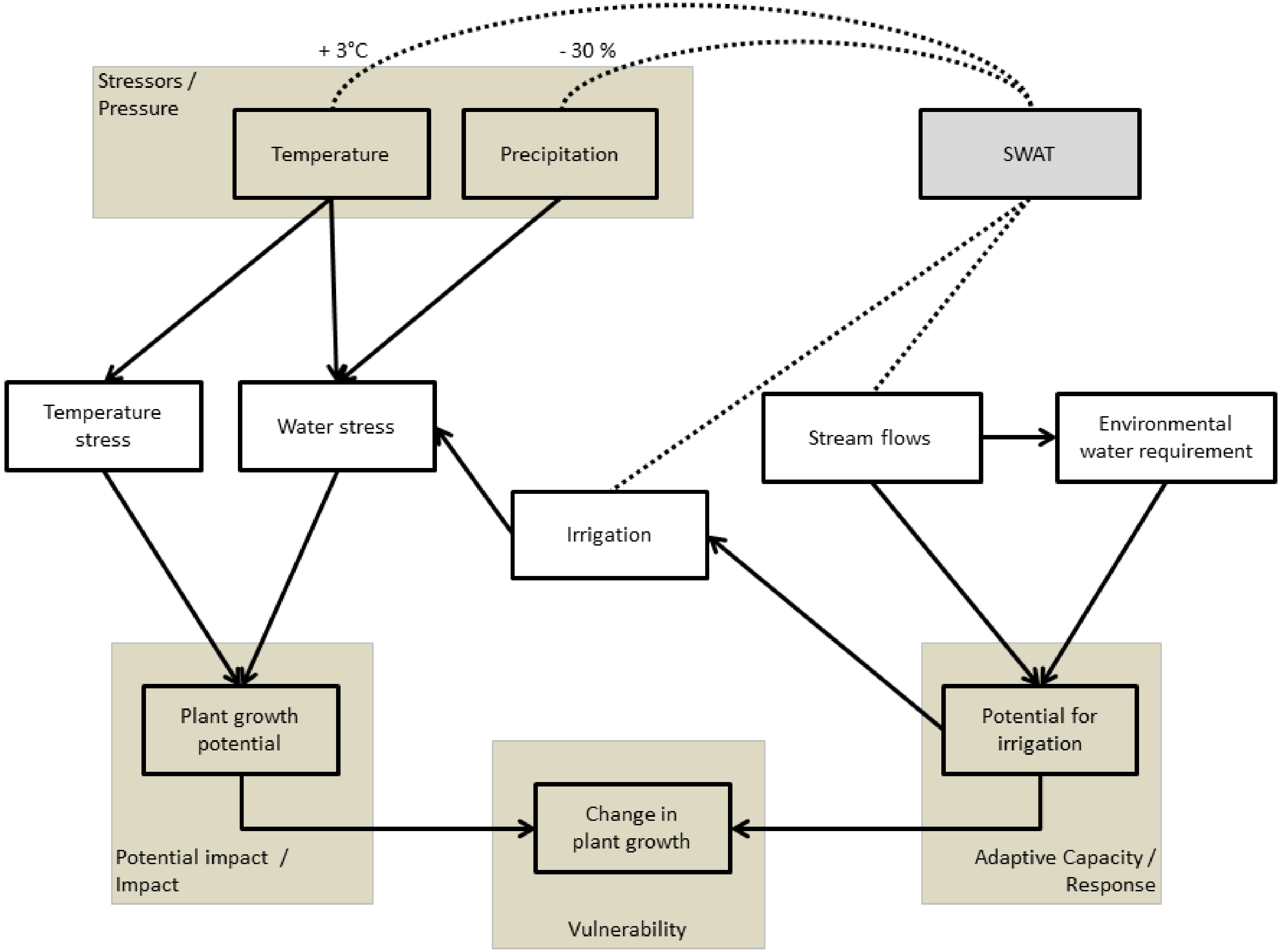
- **Temperature stress**
  A temperature stress day is as day when the average daily air temperature is below 5°C or above 35°C

- **Water stress**
  A water stress day is a day where the average daily evapotranspiration (minus irrigation water) is less than half of the potential daily evapotranspiration.

- **Environmental water requirement**
  The daily environmental water requirement is estimated by calculating 80% of a 10-year average stream flow for each respective day.

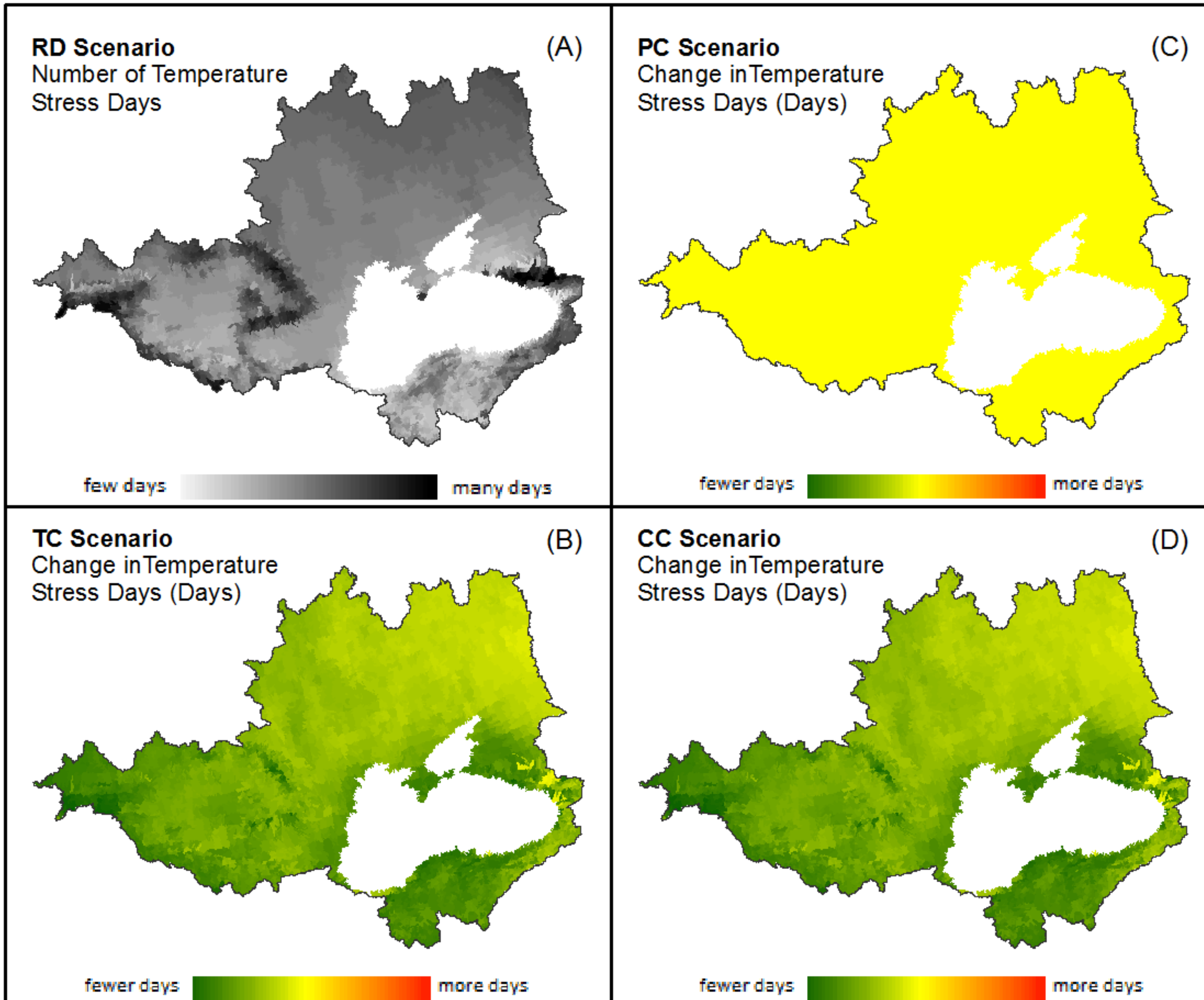


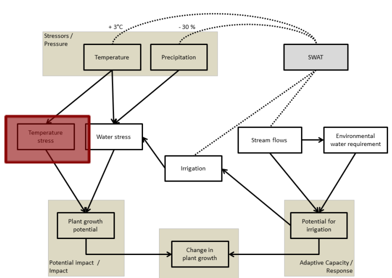
# Methodology



# Temperature Stress





# Water Stress

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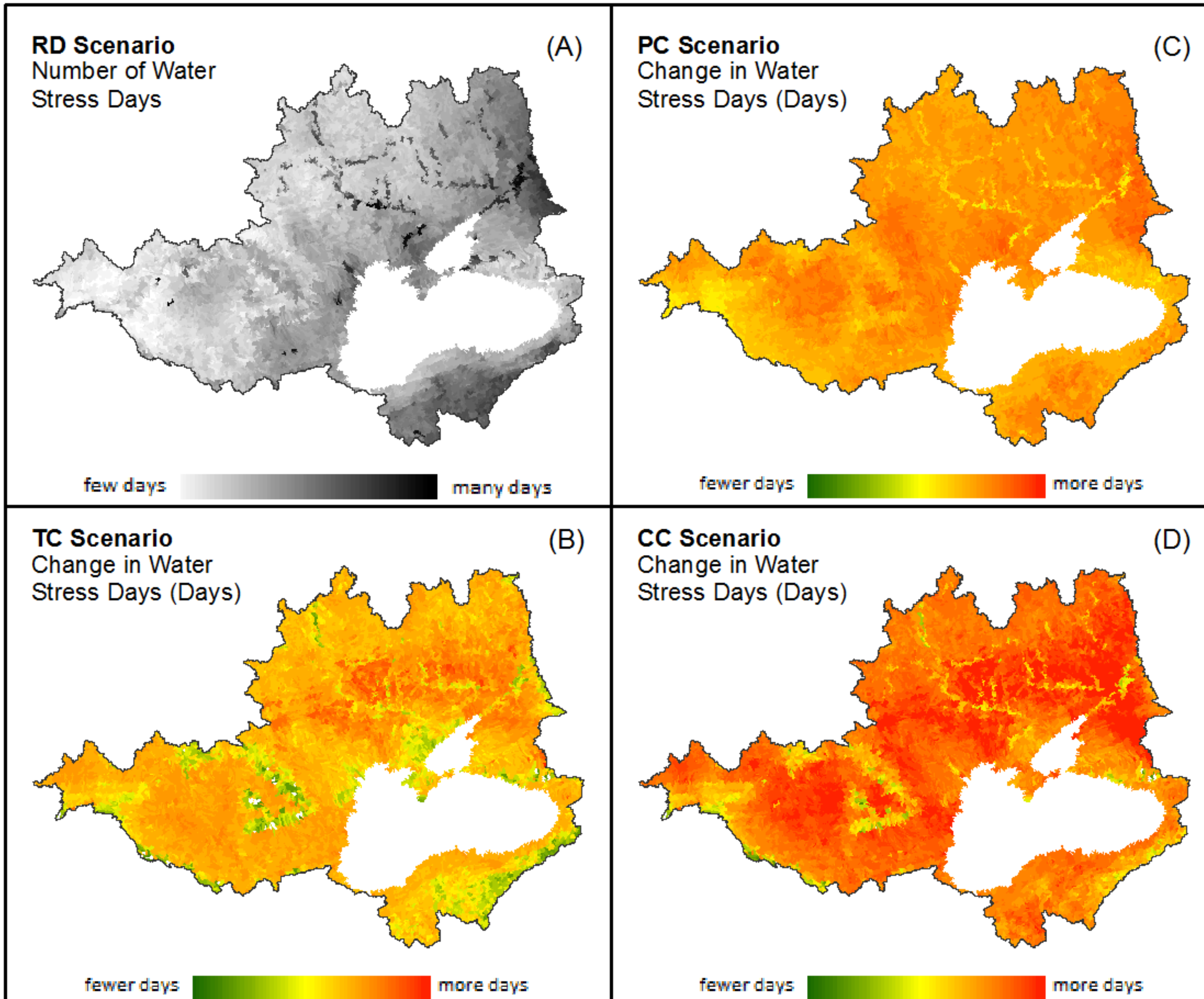


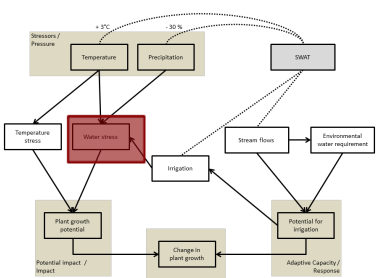

# Potential Climate Change Impact

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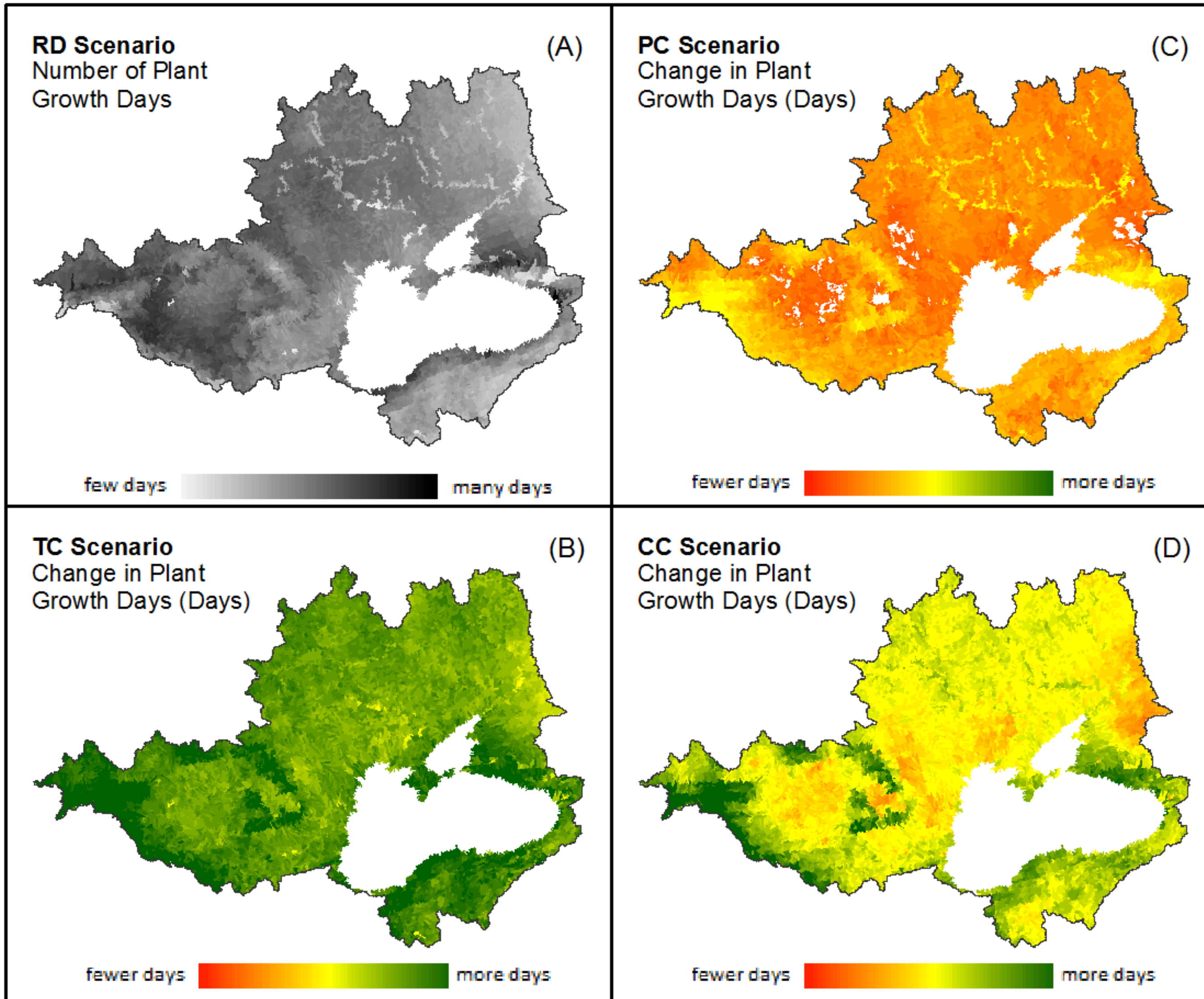
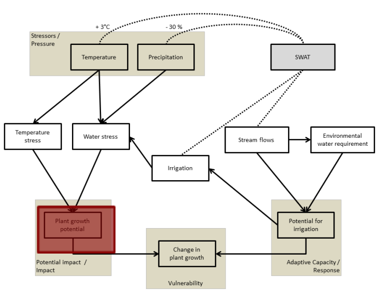
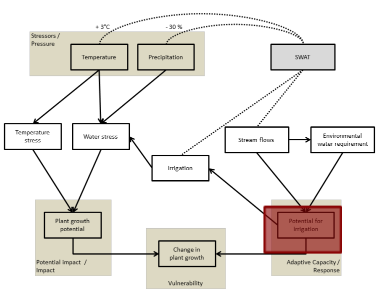
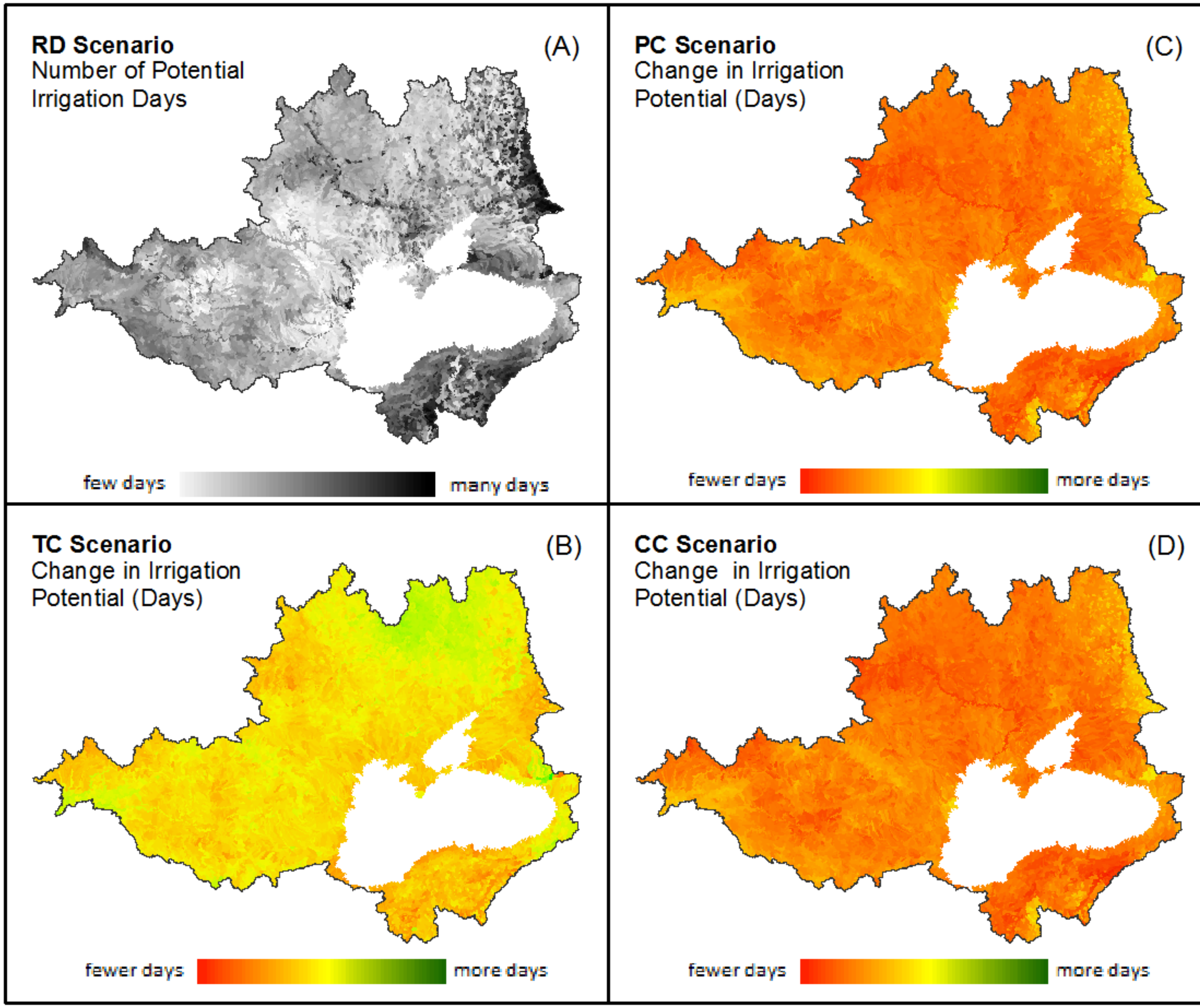


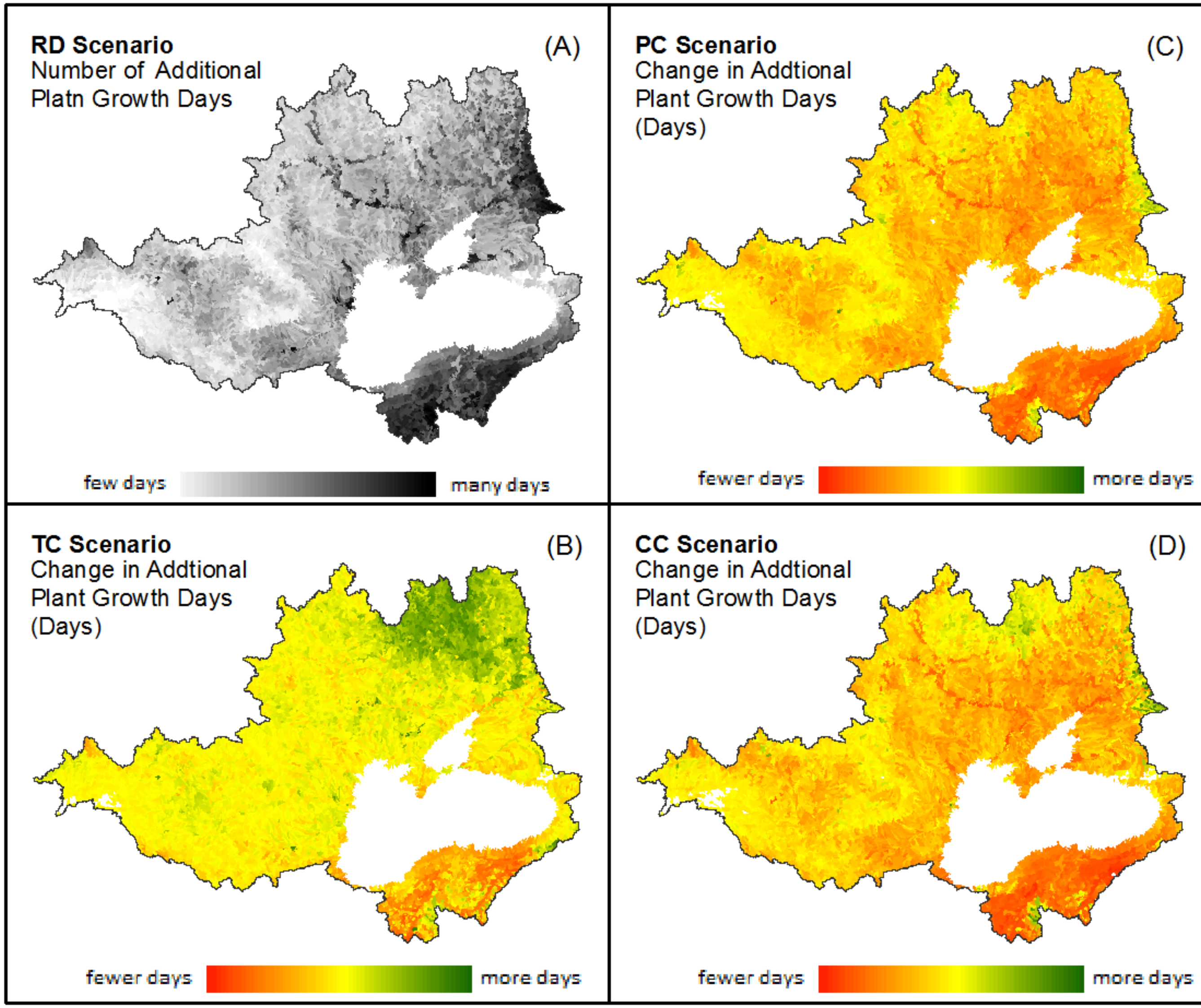


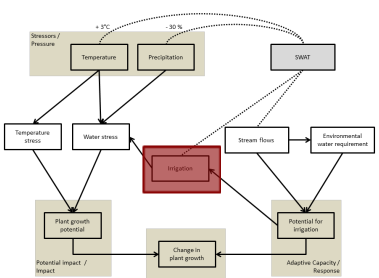

# Irrigation Potential



# Adaption by Irrigation





# Water Vulnerability for Agriculture

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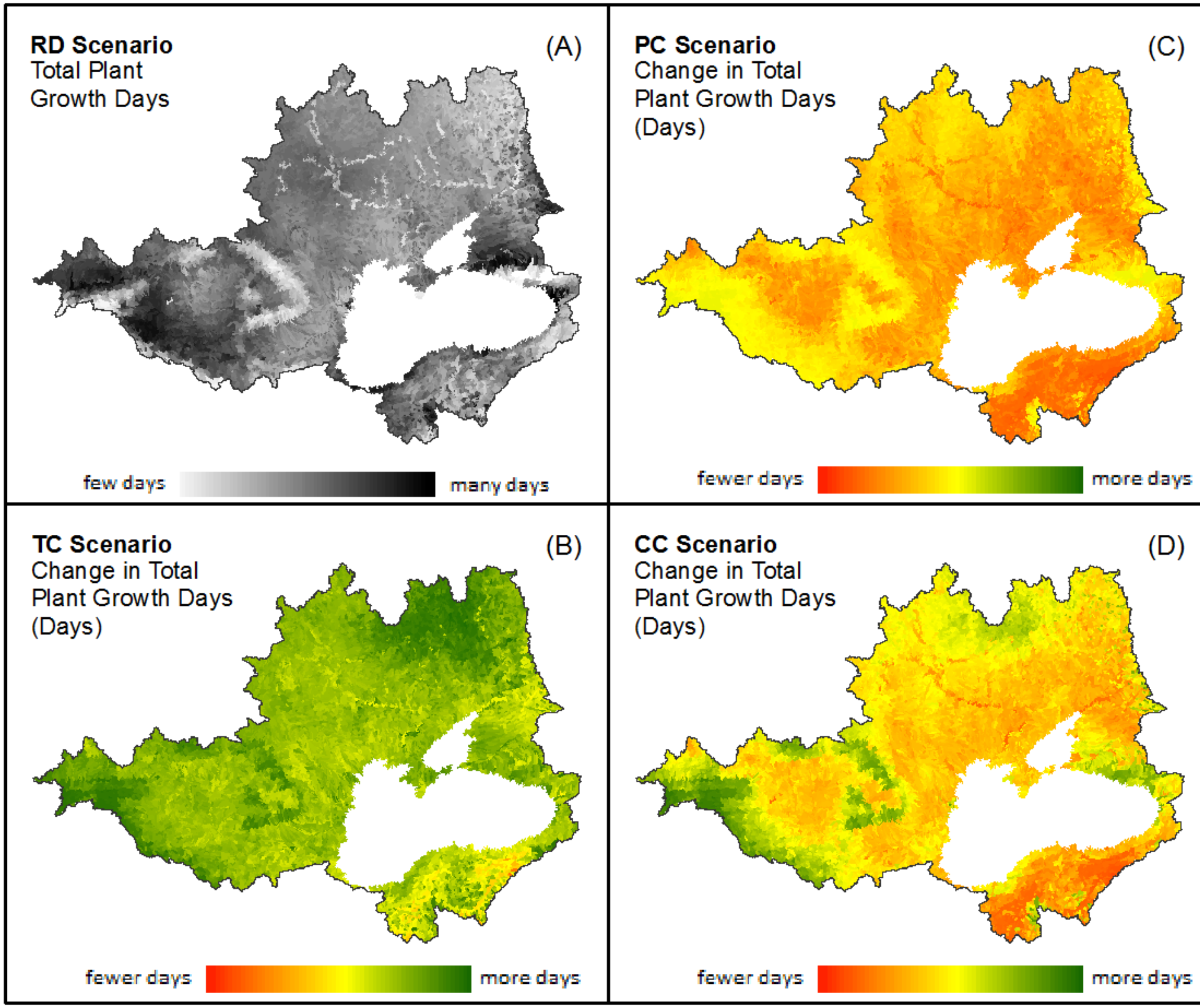


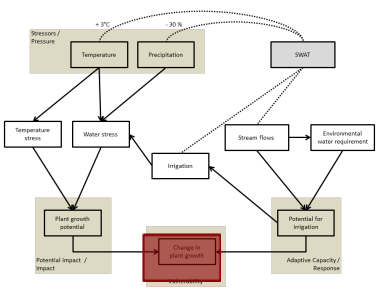

# Country Comparison

| Country | Total Number or Plant Growth Days under the RD Scenario | **Change in Total Plant Growth Days (CC)** | Change in Natural Plant Growth Days (CC) | Change in Temperature Stress Days (CC) | Change in Water Stress Days (CC) | Change in Addtional Plant Growth Days (CC) | Change in Potential Irrigation Days (CC) |
|---|---|---|---|---|---|---|---|
| Albania | 76.2 | 18.5 | 28.1 | -44.9 | -37.3 | -3.0 | -3.9 |
| Austria | 188.9 | 12.8 | 21.5 | -39.1 | 29.6 | -4.4 | -49.7 |
| Belarus | 171.7 | -7.1 | 7.1 | -31.0 | 21.6 | -8.9 | -92.6 |
| Bosnia Herzegovina | 205.5 | 6.9 | 18.2 | -36.1 | 33.6 | -5.9 | -60.3 |
| Bulgaria | 168.4 | -13.5 | 16.8 | -35.0 | 35.8 | -16.5 | -68.3 |
| Croatia | 215.3 | 2.7 | 8.1 | -35.0 | 45.8 | -4.9 | -65.8 |
| Czech Republic | 182.5 | -7.8 | -7.3 | -36.4 | 56.7 | -9.0 | -95.5 |
| Georgia | 149.4 | 1.3 | 16.6 | -32.1 | 15.1 | -9.2 | -39.6 |
| Germany | 208.0 | 8.2 | 27.5 | -40.0 | 33.1 | -4.1 | -74.9 |
| Hungary | 184.0 | -14.1 | -9.0 | -34.0 | 61.1 | -9.6 | -75.0 |
| Italy | 100.8 | 31.4 | 46.6 | -45.7 | -19.0 | -1.0 | -6.5 |
| Montenegro | 136.1 | 14.3 | 29.4 | -39.9 | -9.9 | -6.7 | -32.3 |
| Poland | 169.4 | 7.2 | 15.8 | -34.7 | 4.7 | -4.8 | -62.5 |
| Moldova | 168.9 | -17.8 | 1.0 | -32.5 | 26.1 | -13.7 | -71.4 |
| Romania | 166.7 | -10.1 | 3.8 | -33.9 | 35.0 | -9.8 | -67.5 |
| Russia | 158.2 | -8.0 | 12.0 | -28.8 | 15.3 | -8.2 | -64.7 |
| Serbia | 193.3 | -6.6 | -1.9 | -34.8 | 54.5 | -8.6 | -69.6 |
| Slovakia | 176.7 | -5.4 | -3.9 | -34.8 | 39.6 | -8.7 | -71.8 |
| Slovenia | 212.6 | 13.7 | 22.6 | -36.6 | 27.5 | -2.2 | -49.3 |
| Switzerland | 61.5 | 39.8 | 57.1 | -45.1 | -43.4 | -0.1 | 0.9 |
| Macedonia | 179.6 | -4.4 | 6.4 | -36.4 | 43.6 | -6.8 | -46.7 |
| Turkey | 172.9 | -33.5 | -1.1 | -37.0 | 38.5 | -40.7 | -89.2 |
| Ukraine | 166.5 | -14.3 | -0.5 | -31.1 | 33.4 | -13.9 | -81.5 |

- Opposition of Potential Impact (+) and Adaption Capacity (-)
- Difficult to compare with other studies, but no opposing results (e.g. competition btw environment and agriculture)
- Improvements:
  - Use outputs from Climate Change scenarios and uncertainty;
  - Improve indicator and threshold definitions;
- Smaller discrepancy between the theoretical framework and the actual analysis method
- Appropriate combination of the two concepts, but DPSIR not convenient for climate change analysis

## Main Results

- Agriculture plays key role as the larger water consumer
- Differences between regions (e.g. mountains and Turkey)
- Better natural conditions – worse irrigation potential

## Policy Implications

- Aggravated competition as irrigation will increase
- Sustainable water resource management (e.g. WFD)
- Effective and sustainable agronomic practices (deficit irrigation, waste water irrigation, pressurized irrigation systems)

## Scope for Further Research

- Extent to other sectors of climate vulnerability
- Integrate water resources from groundwater

# More on the enviroGRIDS project


www.envirogrids.net

благодаря

спасибі

teşekkür ederim

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спасибо

# THANK YOU

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