UNIVERSITY OF TRENTO - Italy

Anticipating the impact of **CLIM**atic changes on future **A**vailability of **W**ater **RE**sources and hydro-geological risks: an overview from the project **CLIMAWARE**

Abera W., Bancheri M., Bellin A., Bozzini E., Conci N., Fracasso A., Fraccarollo L., Geneletti D., Giovannini L., Laiti L., Larcher M., Majone B., Meninno S., Nucci E., Pertile M., Piccolroaz S., Rosatti G., Sansone E., Sartori M., Scolozzi R., Tomasi E., Toro M., Turrini P., Zardi D., Zorzi N., Zugliani D., Schiavo S., Rigon R.

lavinia.laiti@unitn.it

Outline

- Introduction
- Focus of the project
- Structure of the project
- Anticipation
- Task 1
- Task 2
- Task 3
- Task 4
- Task 5
- Other activities
- Conclusions

Introduction/1

Project **CLIMAWARE**

- **CLIM**atic change impacts on future **A**vailability of **W**ater **RE**sources and hydro-geological risks

- Call Research Projects 2014 (University of Trento):
  - major themes of cross-cutting interest
  - interdisciplinary joint initiatives
  - significant cultural, economic, environmental and social impacts
  - participation of young scientists

- May 2015 - end of 2016 (18 months)

Introduction/2

Project **CLIMAWARE**

- University of Trento - structures involved:
  1. CUDAM (University Centre for Advanced Studies on Hydrogeological Risk in Mountain Areas)
  2. DEM (Department of Economics and Management)
  3. DICAM (Department of Civil, Environmental and Mechanical Engineering)
  4. DISI (Department of Information Engineering and Computer Science)
  5. DSRS (Department of Sociology and Social Research)
  6. JUS (Faculty of Law)
  7. SSI (School of International Studies)

Introduction/3

Project **CLIMAWARE**

- PIs:
  - prof. Riccardo Rigon (DICAM & CUDAM), project coordinator
  - prof. Stefano Schiavo (SSI & DEM), project vice-coordinator

- People involved:
  - 6 PhD students
  - 8 post-docs
  - 7 researchers
  - 5 associate professors
  - 1 full professor

Introduction/4

Project **CLIMAWARE**

- Research fields (not exhaustive):
  - climatology and climate change
  - meteorology, atmospheric physics and dynamics
  - hydrology, water and soil pollution
  - civil engineering, hydraulic engineering
  - environment and sustainability
  - international trade, economic geography
  - global and transnational governance, international law, human rights
  - competitiveness, innovation, research and development

variety/number of disciplines/departments ≈ international projects

Focus of the project/1

- Title: "**CLIM**atic change impacts on future **A**vailability of **W**ater **RE**sources and hydro-geological risks"
- Focus: "interactions between climate change and human activities related to water"

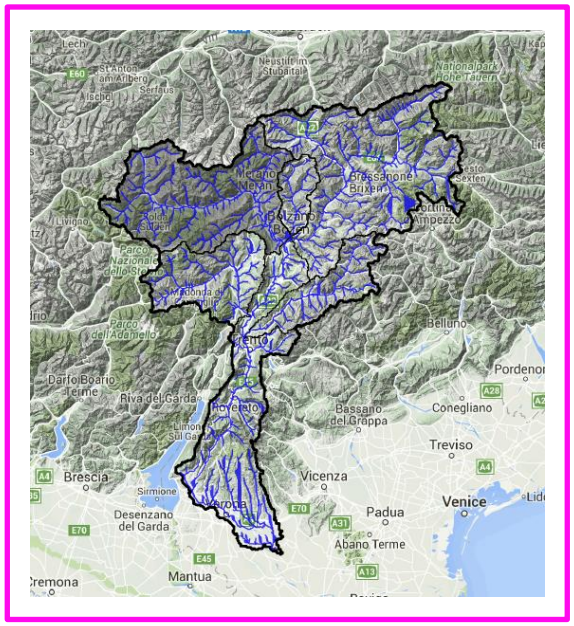
- Climate change:
  - non-stationarity of water cycle components and associated extremes (precipitation, temperature, discharge, ...)
- Water & human activities:
  - freshwater availability for agriculture, tourism, energy production, ...
  - security risk due to floods, land instabilities, debris flows, ...

Climate change Water Human activities

Focus of the project/2

- Target area: Trentino→river Adige basin→Alpine chain→Alpine countries
  - Alps "water towers of Europe"
  - increasing water demand (agriculture, tourism, ...)

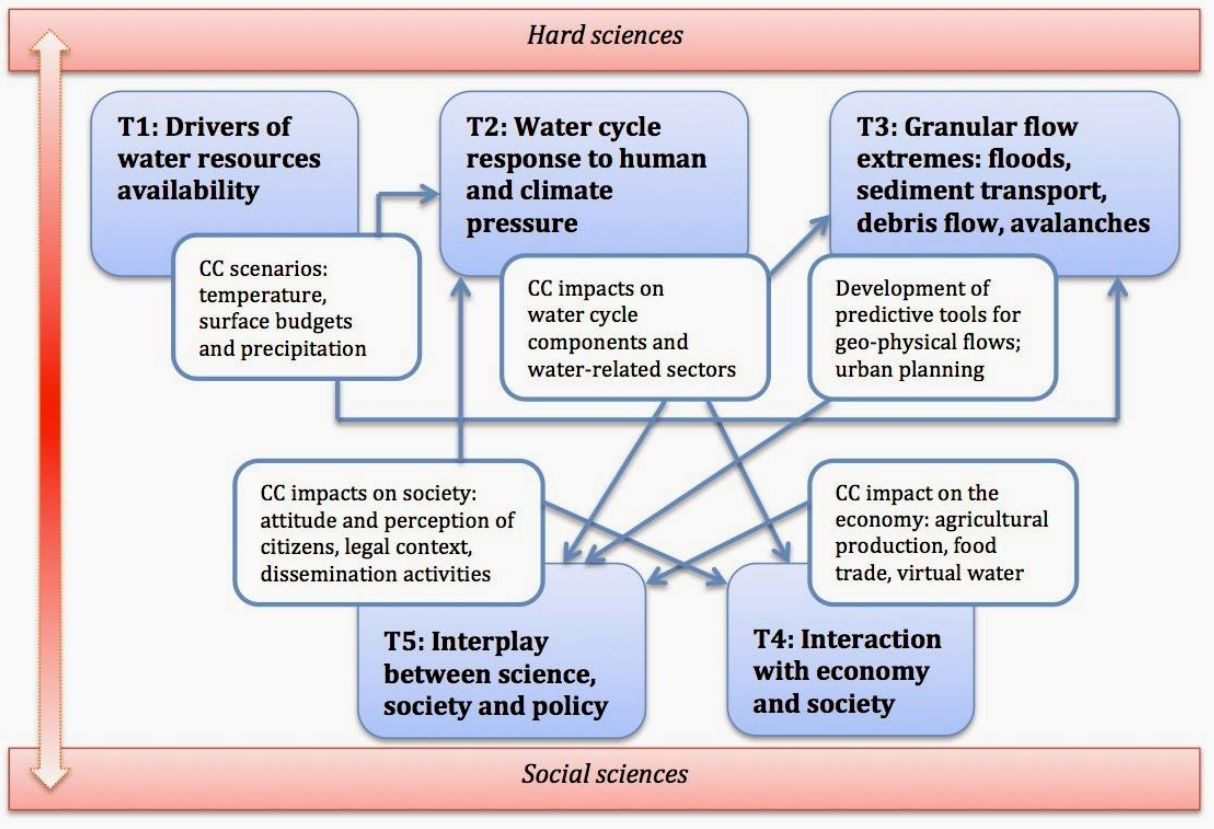
lahistoriaconmapas.com



hydrogeomorpho-metry.blogspot.com

Structure of the project

- 5 interconnected tasks



courtesy of R. Rigon (2015)

Anticipation/1

project ANTICIPATION

United Nations Educational, Scientific and Cultural Organization

UNESCO Chair in Anticipatory Systems

UNIVERSITY OF TRENTO - Italy

Home | Anticipation 2015 | The Project | Ideas & News | Network | search...

Home | Anticipation 2015 | Featured Sessions | **Anticipatory Engineering**

Anticipatory Engineering: more than business as usual?

Print Email

We welcome topics exploring how anticipation could illuminate problems in engineering, including but not limited to

- The role of modelling
  - o Do we need more complex models in engineering that include diverse and contested values, and that deal with specifying uncertainty (e.g. probabilistic models)?
- Engaging in dialogue
  - o What avenues exist for improving the dialogue between engineering and in particular the social sciences? What new methods of collaboration can we devise and implement?

Anticipation/2

The role of modelling: dealing with complexity and uncertainty

- Climate, hydrology and hydrogeological risk modelling: temperature, precipitation, runoff, infiltration, aquifers, evapotranspiration, discharge, granular flows, ...
- Modelling the impacts of CC-related changes in water availability and hydrogeological risk on the socio-economic system ...
- Socio-economic scenarios influence on scenarios of climate change, water use and risk management (mitigation/adaptation policies) ...

- So many heterogeneous components and scales of the problem:
  - very complex system to model
  - propagation and growth of uncertainties?

Anticipation/3

Engaging in dialogue: collaboration between engineering and social sciences

- Structure of the project:
  - two-way feedbacks between tasks
  - interactions between research groups
- Interdisciplinarity:
  - hard sciences (climatology, hydrology, ...)
  - social sciences (economics, sociology, law, ...)
- Holistic approach:
  - physical processes
  - social processes
  - economic processes

www.albaproject.it

ho·lis·tic (hō-lĭs'tĭk)

adj.

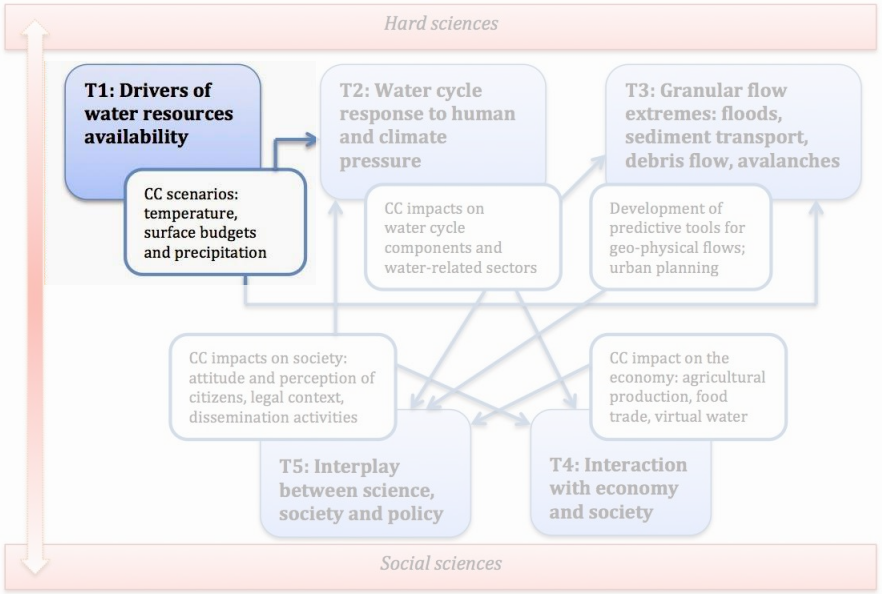
1. Of or relating to holism.
2.
   a. Emphasizing the importance of the whole and the interdependence of its parts.
   b. Concerned with wholes rather than analysis or separation into parts: *holistic medicine; holistic ecology.*

www.ahdictionary.com

Task 1

- "Drivers of water resource availability": climate change effects on temperature, surface budgets and precipitation

- Team leader: prof. Dino Zardi (DICAM & CUDAM)



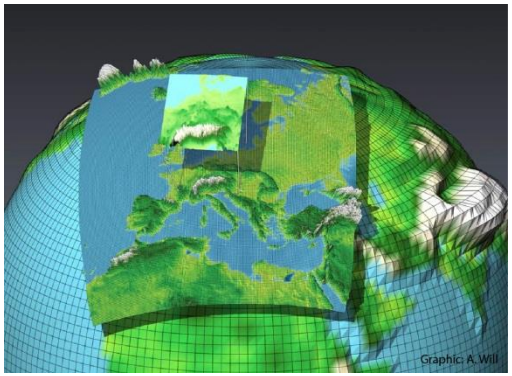
Task 1

- Sub-tasks:
  - selection of climate projections from climate models
  - data rescue for model setup and validation
  - modelling chain setup, test and optimization
  - high-res simulations of selected case studies
  - feedback on the modelling chain

- Expected output:
  - climate change scenarios for the target area
  - high-res future meteorological fields (e.g. precipitation, temperature, ...) for the target area
  - assessment of sensitivity and uncertainty of climate model results

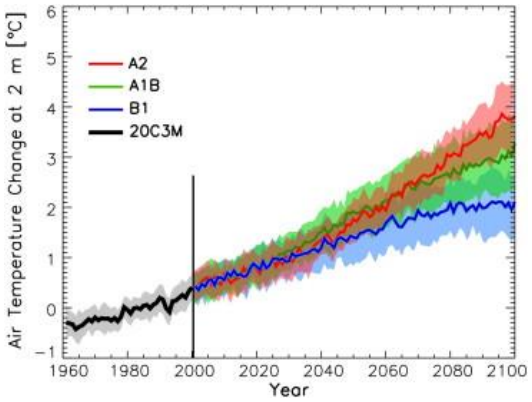
Task 1

- Modelling the Alpine climate for impact studies:
  - General Circulation Models (GCMs, ~100 km)
  - dynamical down-scaling (Regional Climate Models, RCMs, ~1-10 km)
  - statistical down-scaling (based on available observations)



www.clm-community.eu

- Recent projections for 2100:
  - temperature: +4 °C in 2100
  - precipitation: decreases in summer, increases in winter by ± 10-20% (ECO transition)
  - snow cover/days: reduction (+ melting glaciers)
  - extreme events (droughts and floods): increase in frequency and intensity

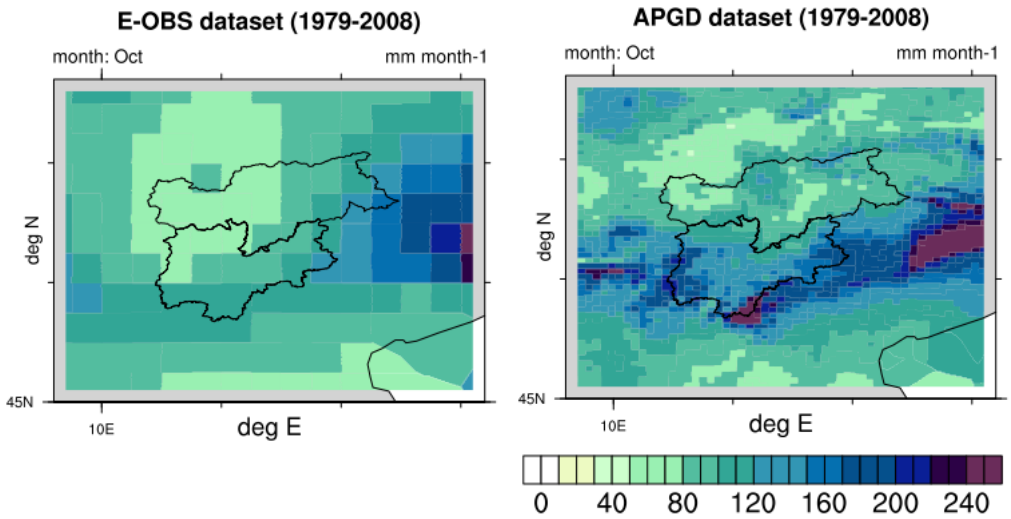


Gobiet et al. (2014)

Task 1

- Added Value of increased RCM resolution, especially for precipitation in mountain regions

- Precipitation dataset commonly used for RCM validation may be affected by significant uncertainties: RCM output validity?



E-OBS: 25 km

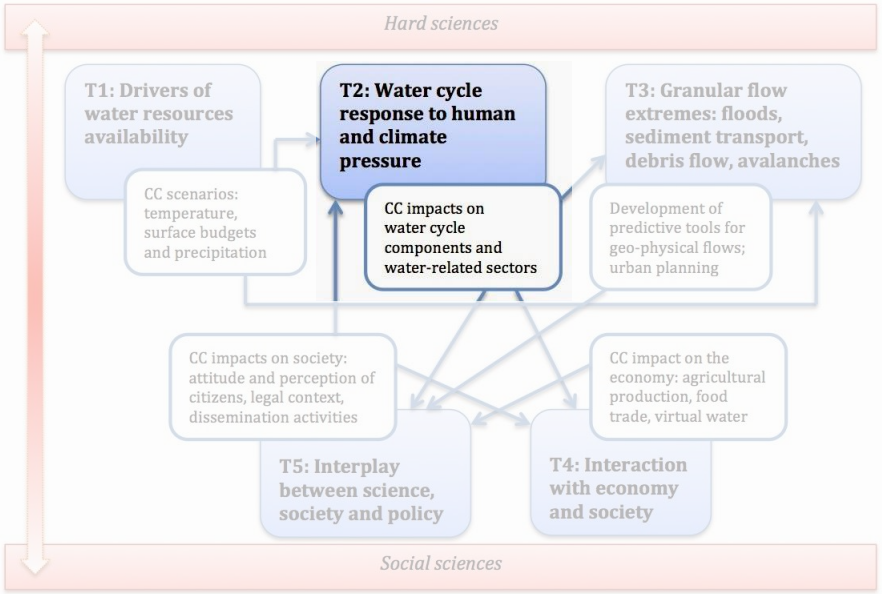
APGD: 5 km

differences: up to ± 150%

Task 2

- "Water cycle response to human and climate pressures": impacts of climate and water use changes on the water cycle in the Adige river basin

- Team leader: prof. Riccardo Rigon (DICAM & CUDAM)



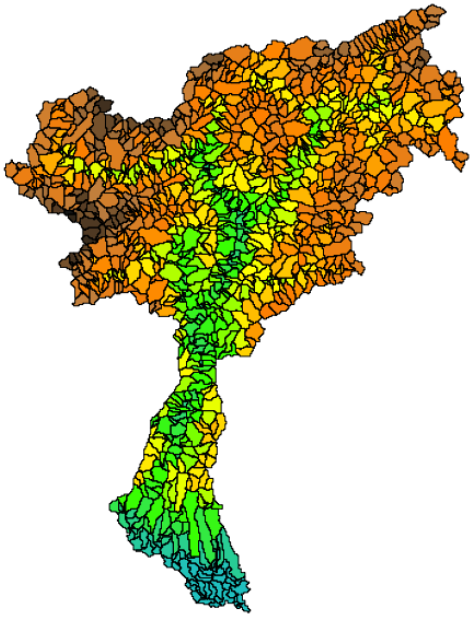
Task 2

- Sub-tasks:
  - develop a conceptual model of the Adige river basin
  - updates and uncertainty assessment of existing models
  - models' calibration and validation
  - simulations of future hydrological scenarios

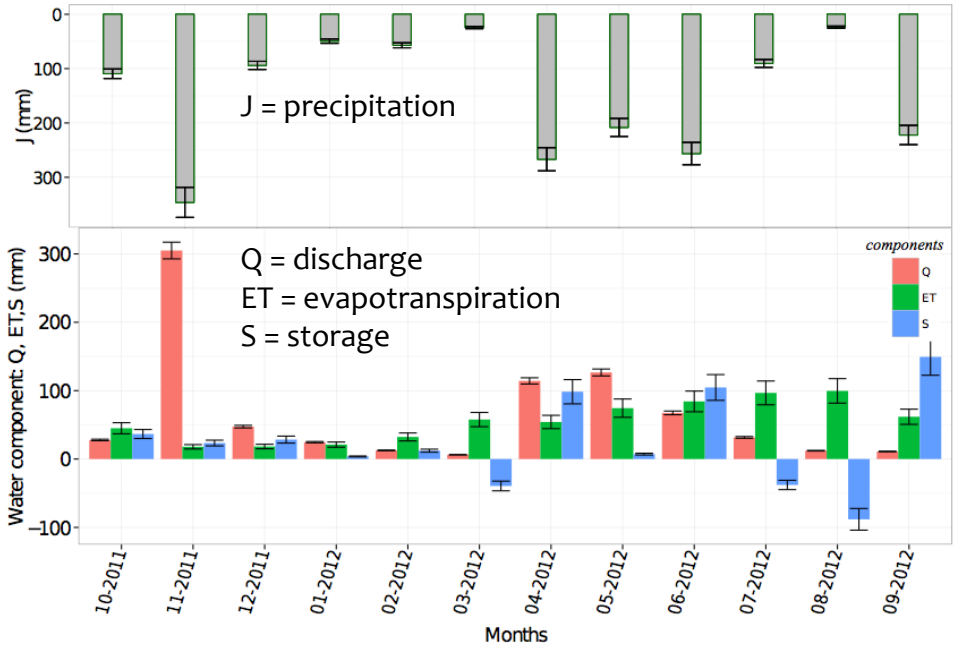
- Expected output:
  - suite of state-of-the-art hydrological models
  - multi-model assessment of the uncertainty of the hydrological budget terms
  - multi-model simulation of climate change impacts on the water cycle for the Adige river basin

Task 2

- Hydrological modelling approach: Hydrologic Response Units (HRUs)
- Spatial scale of hydrological forecasts: HRU (1157 units of ~10 km²)



Courtesy of R. Rigon



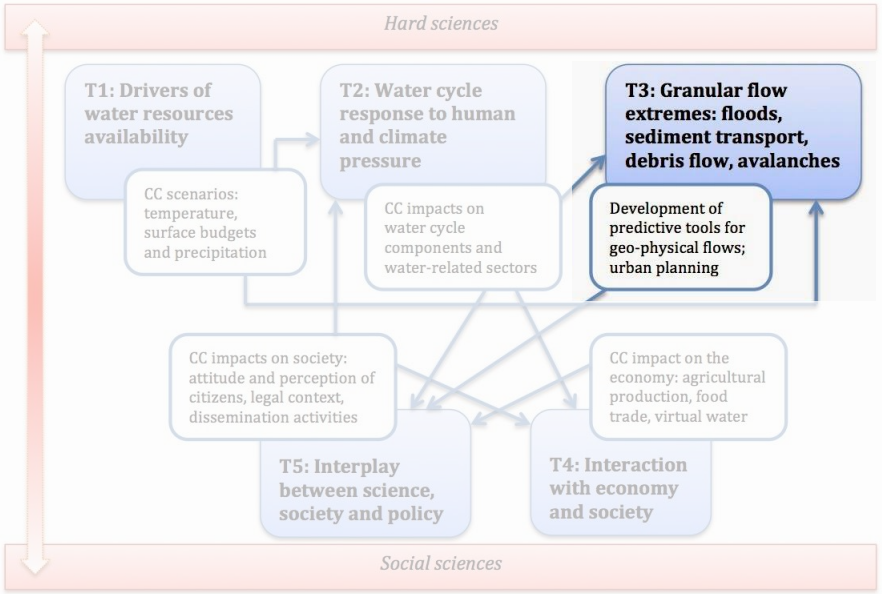
Courtesy of R. Rigon

- Setup of a comprehensive database of Adige river basin hydrology

Task 3

- "Granular flow extremes: floods, sediment transport, debris flows and avalanches": modelling of hydro-geological risks

- Team leader: prof. Michele Larcher (DICAM & CUDAM) + DISI



Task 3

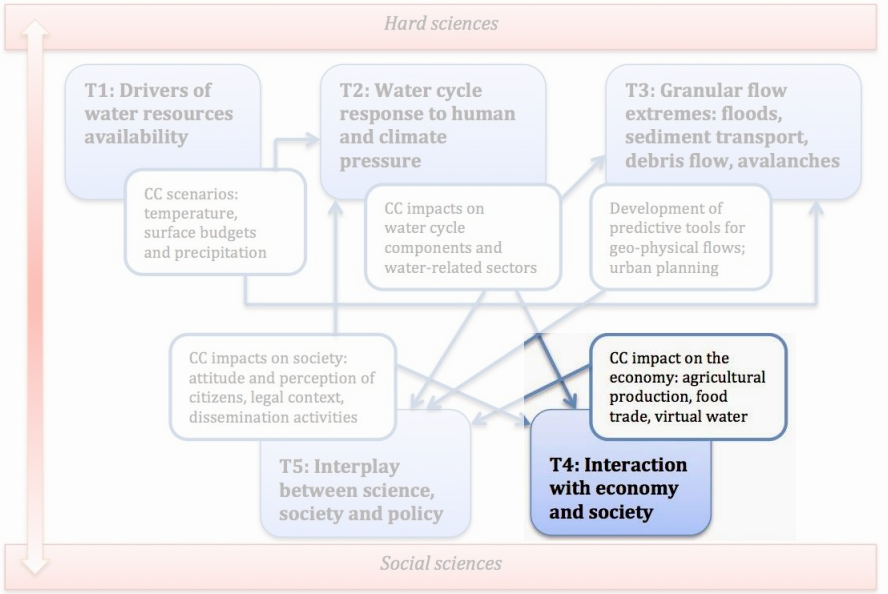
- Sub-tasks:
  - improvement of Trent2D model
  - laboratory analysis on dry and immersed granular flows
  - long-term monitoring of sediment transport in rivers
  - development of an imaging acquisition system for particle tracking in avalanches and debris flows

- Expected output:
  - a webGIS model (Trent2D 2.0) for advanced simulation of sediment transport, debris flows, avalanches, ...
  - experimental database for extreme phenomena
  - model validation against laboratory and field data
  - model simulation of future extreme events

Task 4

- "Interaction with economy and society": analysis of economic and social effects of changes in water availability (focus on agriculture)

- Team leader: prof. Stefano Schiavo (SSI & DEM) + JUS



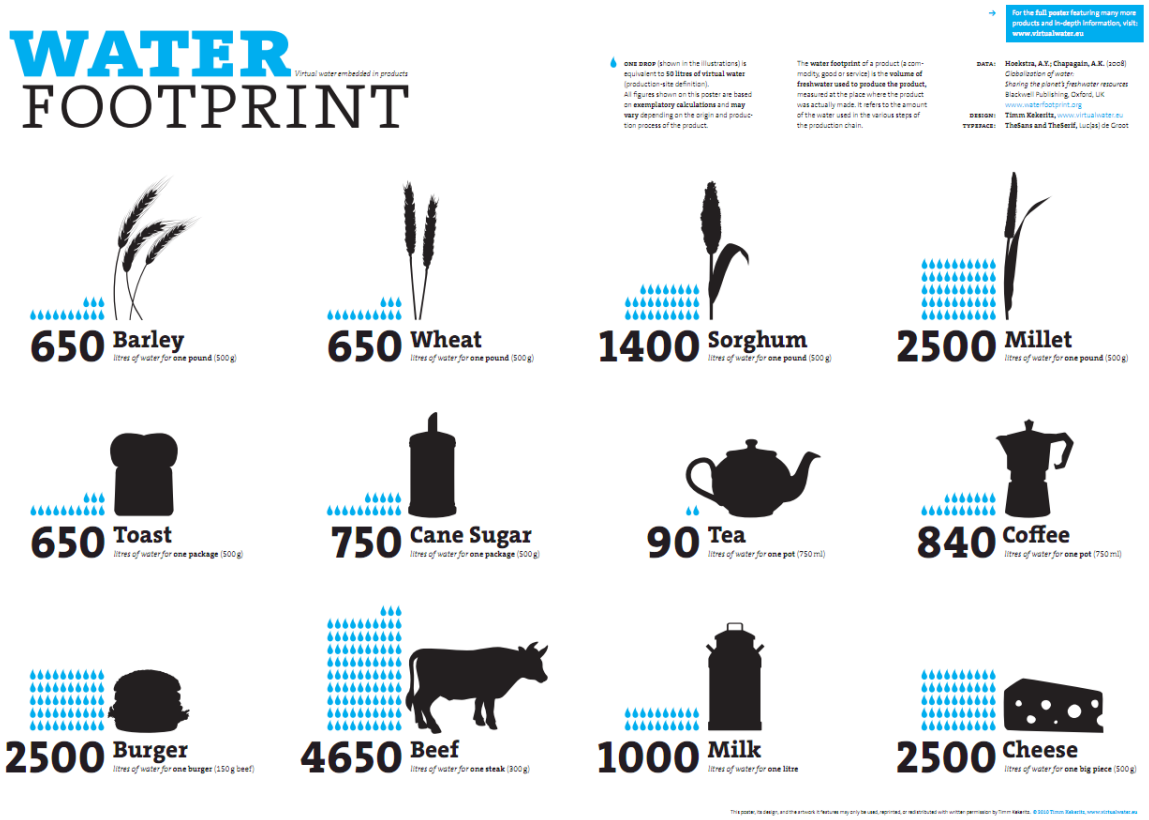
Task 4

- Sub-tasks:
  - development of a computable general equilibrium (CGE) economic model for the Alpine region
  - forecasts of future water availability for food production
  - analysis of trade effects ("virtual water" flows)

- Expected output:
  - global water-oriented CGE model for the Alpine region
  - evaluation of structural economic adjustments driven by changes in water availability for agriculture
  - quantification of changes in food trade patterns ("virtual water" flows)
  - assessment of the effects of strategic adaptation policy options

Task 4

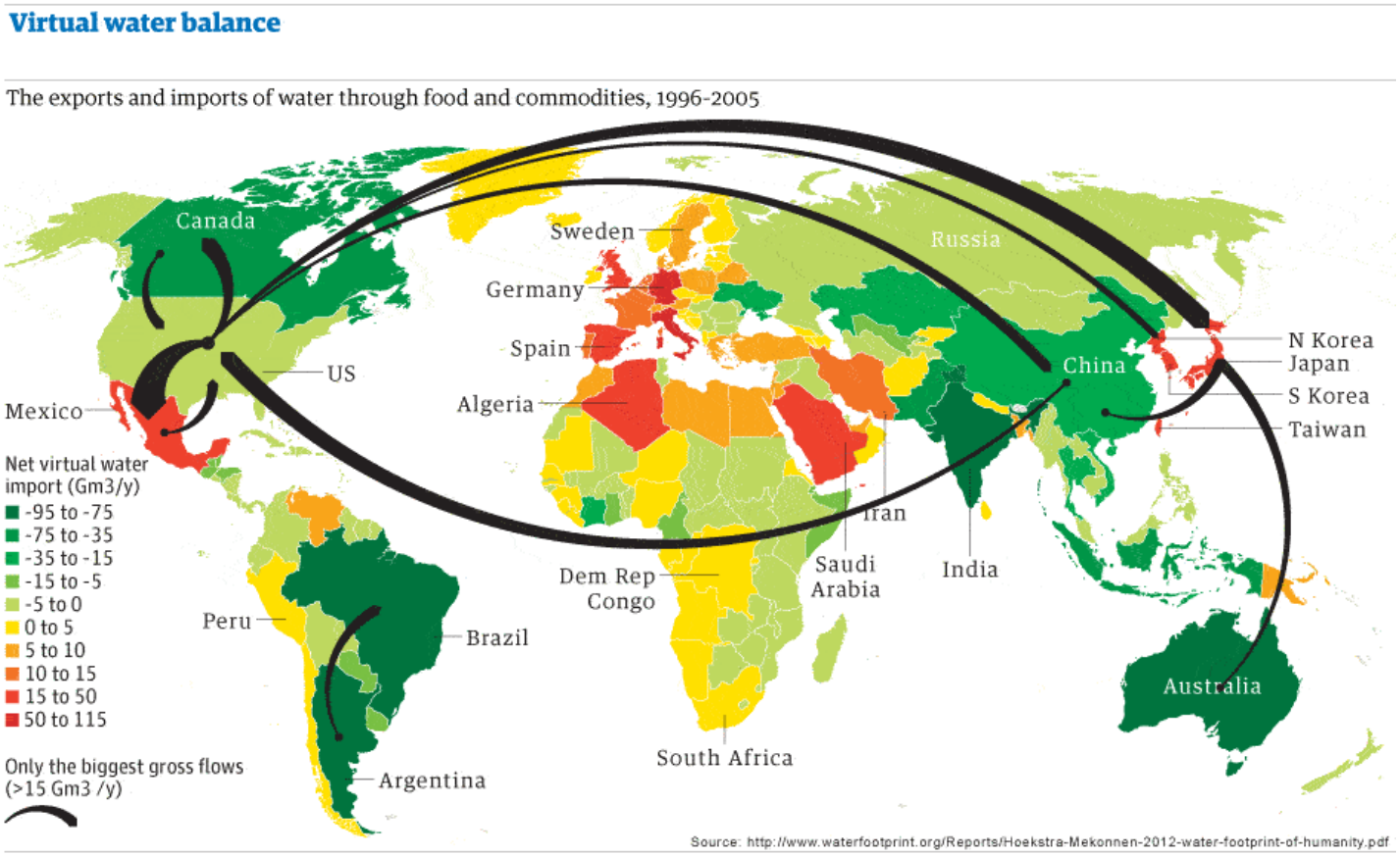
- The paradigm of “virtual water”



virtualwater.eu

Task 4

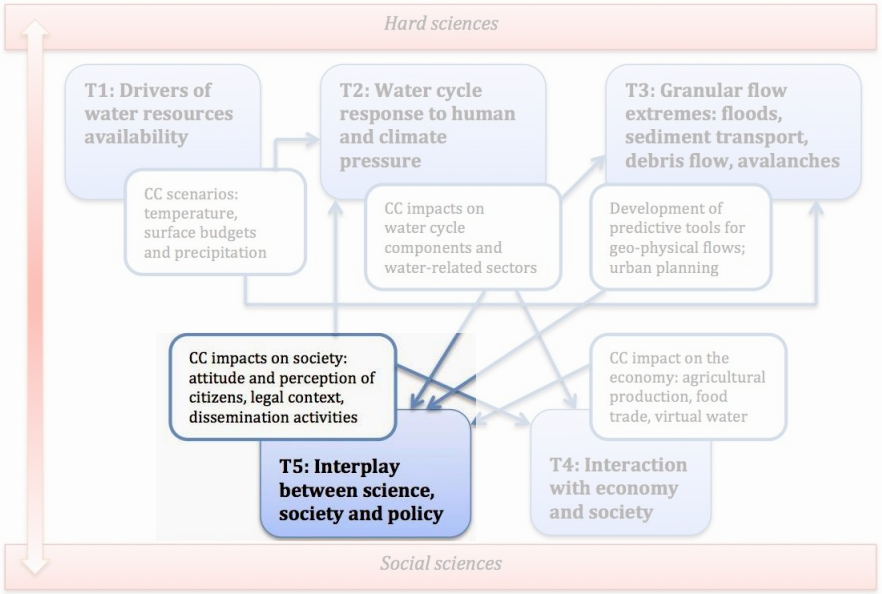
- The paradigm of "virtual water"



Task 5

- "Interplay between science, society and policy": bridging the science-society gap (key vulnerabilities, support to decision-making)

- Team leader: Davide Geneletti (DICAM) + DSRS + SSI + JUS



Task 5

- Sub-tasks:
  - review of policies and legal instruments related to adaptation strategies to climate-induced changes in water availability
  - sociological study of Trentino stakeholders' concerns, awareness, views on mitigation/adaptation strategies to climate change
  - development of vulnerability scenarios and multi-criteria analyses

- Expected output:
  - multi-criteria rankings of stakeholders' policy preferences and priorities on mitigation/adaptation options
  - set of spatially-explicit vulnerability scenarios
  - policies and legal proposals to counter natural- and human-based water stress

Other activities/1

- Seminars (internal/external speakers) to build a common background and stimulate interactions:
  - 13 May: "Building natural risk culture" (M. Olmedo, Kent University)
  - 4 Jun: "Uncertainty in climate modeling of precipitation: from large to small scales through downscaling" (E. Palazzi, CNR ISAC)
  - 21 Oct: "Modelling the climate of Alpine areas" (L. Laiti, DICAM)
  - 29 Oct: "Global Food Security workshop" (S. Schiavo, M. Sartori, SSI)
  - 11 Nov: "Granular flow extremes: floods, sediment transport, debris flows and avalanches" (CUDAM, DICAM, DISI)
  - 2 Dic: Task 4
  - 9 Dic: Task 5
  - 16 Dic: Task 5
  - …

Interested in attending? lavinia.laiti@unitn.it

Other activities/2

- Project meetings
- Papers in international journals
- Guidelines for EU Water Directive 2000/60 and Flood Directive 2007/60 (Alpine Convention)
- Technical reports
- Communications in (inter)national meetings
- Organization of schools, workshops, ...
- PhD/Master theses
- Dissemination meetings open to citizens
- Researchers' Night 2016
- Festival dell'Economia 2016
- ...

aerocoins.eu

www.stayontrack.eu

Conclusions

- CLIMAWARE project: Climate change, Water, Human activities, Water availability, Hydro-geological risk
- Focus: interplay between physical and human processes in relation to water resources and hydro-geological risk under climate change conditions
- Target area: Adige river basin and Alpine area
- 5 interconnected tasks
- Interdisciplinary approach
- Holistic approach
- Anticipatory approach:
  - explicitly dealing with different types of data and modelling uncertainties (scenarios, multi-model approach, ...)
  - interaction between engineering and social sciences

Conclusions

- Expected outcomes and impacts:
  - better assessment of climate change effects on water resources, water uses, water-related security risks for the target area
  - see how uncertainty grows through the chain of different models and assess its relevance to decision-making processes
  - increased social awareness and perception of climate-related risks
  - improved capacity of mitigation/adaptation options implementation
  - increased awareness of the benefits of cooperation between disciplines

Bridging the gap between science and society

Thank you for your attention!

the CLIMAWARE team