Hydroclimatic variability, future water resource and water demand for the Durance River Basin

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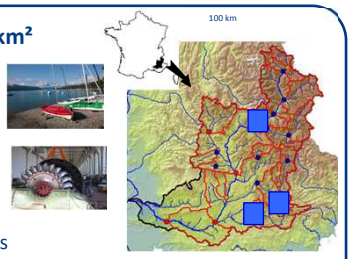
The Durance River basin, 14 000 km²

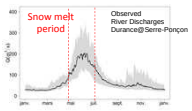
- a major river in SE France
- heterogeneous climate
- river flow regimes highly altered



- **3 large multipurpose reservoirs**
  + extended open channel network to supply water demands within and out of the basin boundaries
- "water tower" crucial for the socio-economic development of South Eastern France

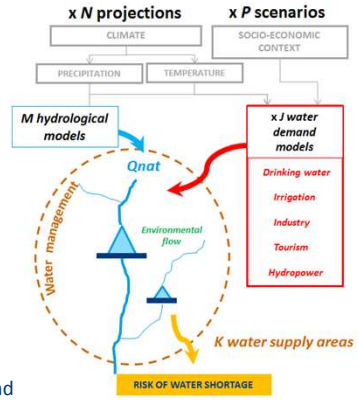
Among keys issues :

- Future water availability and risks of water shortage in the next 100 years resulting from changes in climate and water management
- Uncertainty sources in hydroclimatic projections and significance of changes compared to climate unforced variability



A MULTI-MODEL MULTI-MEMBER APPROACH

- **11** runs from 5 ENSEMBLES GCMs under the 20CM3+A1B experiments downscaled with **6** variants of the analogs (100 replicates) to provide **6600** * 240 years regional climate projections (Lafaysse&coll.2014)
- **6** hydrological models (physically based, conceptual) forced by a subselection of **330** climate projections to estimate water resources (Vidal&coll. sub)
- **3** models for irrigation water demand (Braud&coll., sub.)

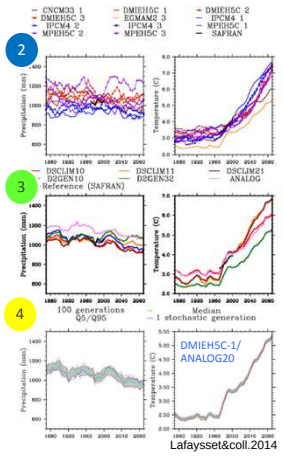


R2D2 extended multimodel framework, Sauquet&coll.2014

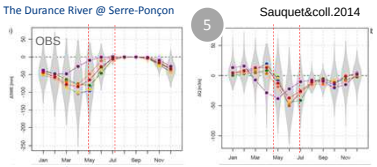
- **1** econometric model to estimate present / future domestic water supply (Sauquet&coll.2014)
- **3** models of reservoir water management, with irrigation + hydroelectricity production objectives under ecological/touristic constraints (François&coll. 2015).
- **4** territorial socio-economic scenarios elaborated with stake holders to project water uses (Sauquet&coll.2014)
- + statistical frameworks for scenarios subselection, partitioning internal variability and model uncertainty components in hydroclimatic projections

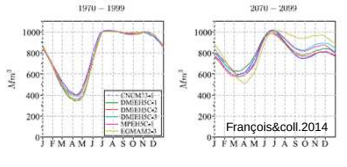
FUTURE REGIONAL CLIMATE and WATER RESOURCE

- ↑ air temperature
- High dispersion in fut. precipitations
- High dispersion in fut. annual discharges
- ↑ in evaporation losses
- ↓ in snowpack
- Earlier and reduced spring snowmelt flood
- ↑ stress; water demand above the current allocated volume in the largest reservoir for the business as usual scenario
- ↑ summer water resources shortage (↑ low flow severity, ↑ peak irrigation demand)
- modification of reservoir storage strategy ↓ hydroelectricity production
- ↑ irrigation needs, ↓ summer lake level, …



Lafaysset&coll.2014

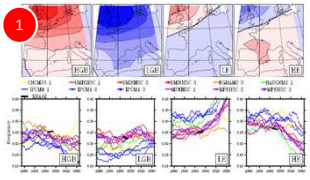




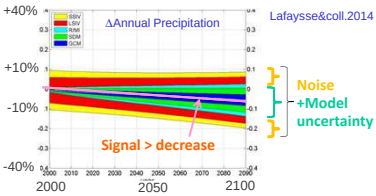
Mean Interannual storage trajectories in Serre Ponçon Reservoir

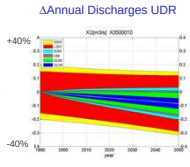
MODEL UNCERTAINTY , INTERNAL VARIABILITY

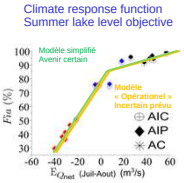
1. Large Scale IV from multidecennal fluctuations of atmospheric forcings
2. Small Scale IV/ downscaling process
3. Dispersion between GCMs
4. Dispersion between Downscaling Models
5. Dispersion between Hydrological Models



Time evolution of weather type frequency / 1860-2100







François&coll.2015

- Temperatures and relative variables >> significant changes
- Precipitation and related variables >> changes non significant (dominant contribution of Internal variability including Small Scale)
- Downscaling Model uncertainty ~ GCM uncertainty !
- Hydrological Model uncertainty smaller but not negligible (ET formulation)
- No influence of Model Management structure / climate response functions
  - > Relevance of simplified models with less computational costs

RELEVANT PUBLICATIONS

Lafaysse&coll.2014. Internal variability and model uncertainty components in a multireplicate multimodel ensemble of hydrometeorological projections. Wat.Res. Res.

Magand&coll.2014. Parameter transferability under changing climate: case study with a land surface model in the Durance watershed, France. Hydrol. Sci. Journal

François&coll.2015, Influence of the management strategy model on estimating water system performance under climate change. Wat.Res.Manag.

Braud&coll. 2015. Quantifying climate change impact on irrigation requirements in south-east France: intercomparison of four models on nine typical crops. J. Hydrology , submitted

Much more information on models and scientific results from :
http://www.lthe.fr/RIWER2030/ and https://r2d2-2050.cemagref.fr/

Project reports : www.gip-ecofor.org/doc/drupal/gicc/RapportFinal-R2D2-2050.pdf
http://www.lthe.fr/RIWER2030/pdf/RIWER2030RapportFinal.pdf

CONCLUSIONS/PERSPECTIVES

Expected increase in pressure on water resources in the next decades

Full compliance with downstream water needs leads to less hydropower production flexibility during winter peak demand if current management rules are unchanged

Robust adaptations scenarios have to account for large internal variability in the regional climate. This latter needs to be better understand and characterized

ACADEMIC AND INDUSTRIAL PARTNERSHIP

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ACKNOWLEDGEMENT

The research project R²D² -2050 "Risk, water Resources and sustainable Development within the Durance river basin in 2050" is partially funded by the French Ministry in charge of Ecology and the Rhône-Méditerranée Water Agency.

The research project RIWER2030 "Climats Régionaux et Incertitudes, Ressource en Eau et Gestion associée de 1860 à 2100 » is funded by the French National Research Agency under the VCMS program