FROM SEASONAL FORECASTS TO SCENARIOS OF CLIMATIC VARIABILITY

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Context

• Extensive areas of irrigated agriculture – mainly sugarcane – 50% of irrigation from groundwater

• Water scarcity can be an issue during extensive drought periods (El Niño) – flooding during wet periods (La Niña)
Regional environment agency, “Corporación Regional Autónoma del Valle del Cauca” (CVC) mandated with the management / regulation of water resources

Collaborative project “ESCACES” to improve the understanding of the groundwater system and develop tools and strategies to support its sustainable management

Reasonably well developed hydrometeorological observation network (1975 – current date); detailed data on land use, geology/lithology
Regional Groundwater Model – Evolution of groundwater depth (3 layers)

- Monthly evolution of groundwater levels
- Recharge from precipitation & irrigation excess & from rivers
- Groundwater extractions through wells

Context

- How much room is there in the system to support licenced extractions during extended drought periods?
- How quickly do groundwater levels recover after return to “normal” conditions?
Variability of rainfall related to El Niño-La Niña
(as well as to other climatic cycles – Poveda et al., 2011)
## Cross correlation between ENSO indices, rainfall and SPI

<table>
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<tr>
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<th>P</th>
<th>SOI</th>
<th>MEI</th>
<th>ONI</th>
<th>SPI1</th>
<th>SPI3</th>
<th>SPI6</th>
<th>SPI12</th>
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<td>0.72</td>
<td>1.00</td>
</tr>
</tbody>
</table>
Developing an approach to predict the evolution of groundwater levels (2016 – 2025)

Soil Water Balance to estimate g/w recharge
- Land Cover
- Irrigation
- Soil texture & root depth
- Slope etc.


Well Pumping Regimes

Groundwater Model (IMOD-MODFLFOW)

Scenario Generator

Forecasting Platform (FEWS-ESCACES)

Scenarios of groundwater levels
Generating climatic scenarios – conditional on current climatic conditions

K-Nearest neighbour sampling approach to create synthetic future rainfall time series (based on Beersma & Buishand, 2003; Peters et al., 2005, Beckers et al., 2016)

Current data (Precipitation & indices)

Precip: 12, 9
Index 1: +0.6, -1
Index 2: -1.2, 2

Historical data (Precipitation & indices)

Year/Month: 2015/10, 11, 12

1. Establish value of indices for current month
2. Calculate Mahalonobis distance to historical year/months (preserving month)
3. Select K nearest neighbours
4. Randomly select one of K nearest neighbours
5. Select month after as next month in series
SPI-6 for selected forecasts with K=10 (6 examples)
Autocorrelation of SPI-6 series based on resampled rainfall
Rank Histograms for precipitation and SPI-6 forecasts

3 Months  6 Months  12 Months  24 Months  36 Months  60 Months

Monthly Precipitation  SPI-06
Relative Operating Characteristic diagrams for precipitation and SPI-6 forecasts

- Monthly Precipitation
- SPI-06
Correlation forecast/observed and MCRPS
Lead times 0 to 60 months

Correlation of the observations and ensemble average by forecast lead time.
Abonilas.PPN

Correlation of the observations and ensemble average by forecast lead time.
Abonilas.SPI

Mean Continuous Ranked Probability Score (CRPS) by forecast lead time.
Abonilas.PPN

Mean Continuous Ranked Probability Score (CRPS) by forecast lead time.
Abonilas.SPI

Monthly Precipitation

SPI-06
Scenario of climate variability

Scenario 2015-2025 – conditional on g/w levels & pumping 2015
Scenario of climate variability
Scenario 2015-2025 – conditional on g/w levels & pumping 2015
Conclusions & Further Work

• Insight into the development of groundwater resources at the seasonal to scenario timescales – relevant to slow responding groundwater systems

• Approach to developing scenarios conditioned by the current groundwater levels – relatively simple / comprehensible to users

• “Work in progress” – lots of further work to do
  – More elaborate assessment of skill
  – Sensitivity to number of neighbours (K)
  – Weighting of sampled months
  – Sensitivity to other indices (e.g. SPI-6 & SPI-12)
  – Conditioning based on predicted indices e.g.
  – Other datasets to re-sample from instead of observed – CHIRPS, Re-analysis,....